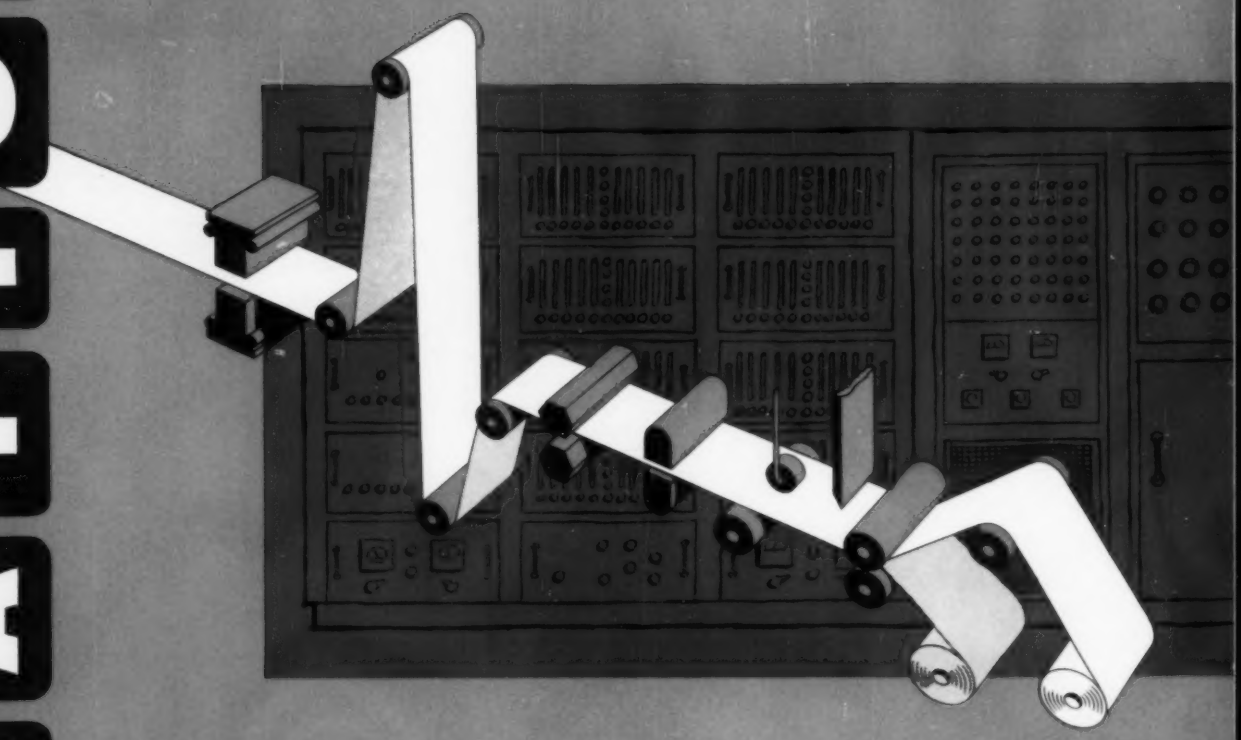
AUTOMATION

NOVEMBER 1958



Using Data Reduction

FOR CONTINUOUS PROCESSES

The Magazine of Automatic Operations

- Making Refrigerator Cabinets
- Mail Processing
- Testing Hardness Automatically
- Building-Block Controls

CONTENTS—PAGE 3

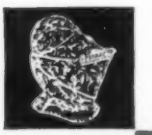
A PENTON PUBLICATION

Whether you figure your parts production in thousands or millions, a Wean "Flying Press" can help cut costs

There is really no minimum production figure at which the ability of the Wean "Flying Press" to reduce cost/piece is diminished. For example, a "Flying Press" sold to a contract stamper is enabling this firm to get more short-run business, since a very competitive price can be quoted.

But where component parts are produced in large quantities, substantial economies are assured with the Wean "Flying Press." Due to the unique design of the "Flying Press," it processes coil at up to 300 fpm *continuously:* the strip never stops for indexing but flows through the "Flying Press" at a uniform rate. This elimination of "stop-and-go" operation, which has characterized and limited conventional stamping presses for years, has a further advantage than speed of production alone: it's easier on the dies. Actual comparative tests conducted by a "Flying Press" user showed that monthly die maintenance was reduced some 36% when standard dies were run on the "Flying Press."

The complete concept of the "Flying Press" takes a good bit of explanation: the practicality of it for your operations also requires the personal service of a Wean Sales Engineer. We suggest that, as a first step, you write us for an illustrated brochure on the "Flying Press": then we can arrange to have a Wean representative call at your convenience to explore the matter further. If you are actively interested in how this unusual piece of processing equipment can serve you, we can run your dies on a demonstration machine at our Cleveland plant.



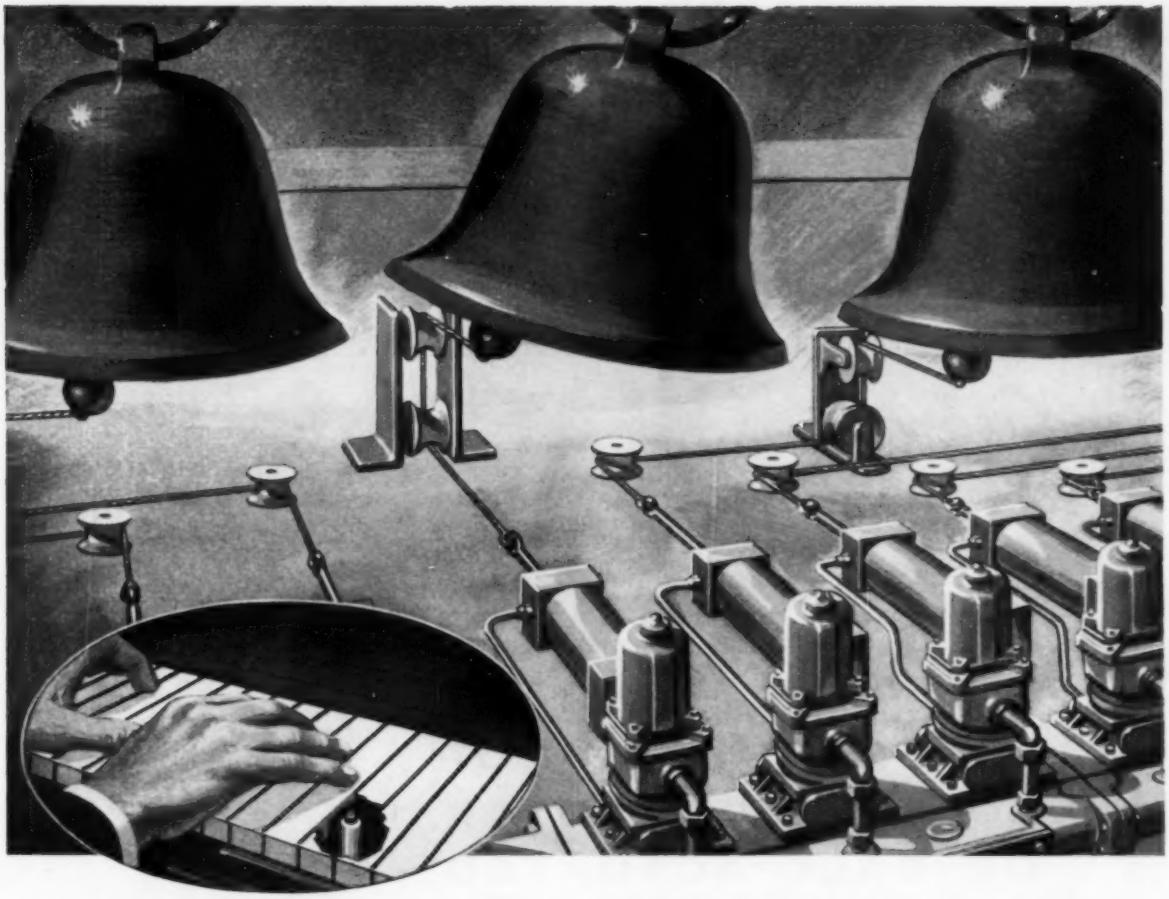
WEAN

WEAN EQUIPMENT CORPORATION

CLEVELAND 17, OHIO

Detroit • Chicago • Newark

Circle 651 on Page 155



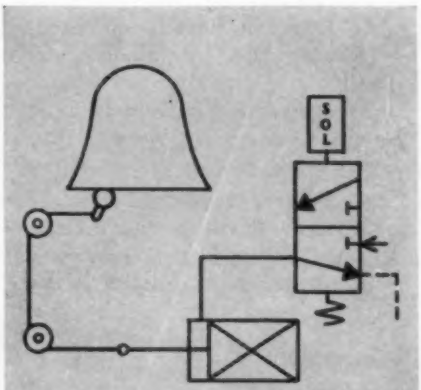
What? Air Power Rings the Bells!

Air powered clappers for the bell tower may be strictly fiction, but . . .

Can you imagine a keyboard that's a set of electrical switches. They operate a set of solenoid valves which in turn advance and retract cylinders. The cylinders, of course, pull the clapper cords. Shows that anything can happen when an air-minded engineer gets in the spirit of the season. But while this is just a flight of the imagination that you aren't likely to see installed in a carillon soon, you might very well want to take advantage of the underlying idea in some of your *plant operations*. Here is the idea:

Just one operator can control hundreds of operations by using solenoid valves.

And these solenoid valves, you'll notice, are manifolded. The manifolding saves piping, space, etc., just as has been possible for years with Ross valves that are operated manually, by air, cams, etc. Incidentally, you won't find this manifold in our catalog . . . it is one of the many refinements and variations of the standard Ross line that make it so flexible. To keep fully aware of the developments continually being made to increase the flexibility of the Ross line, keep in close touch with your local Ross Valve Engineer.



SEQUENCE OF OPERATION

Every time solenoid is energized, bell clapper is pulled against bell.

ROSS OPERATING VALVE CO. 131 East Golden Gate • Detroit 3, Michigan

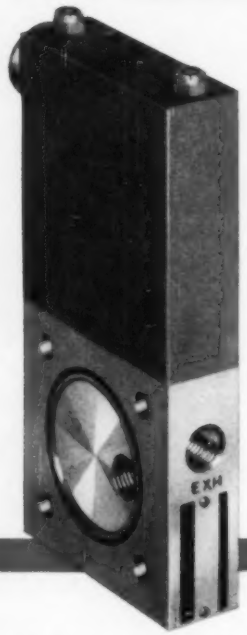
Circle 654 on Page 155

Introducing the new

HUNT

Slim Line VALVES

SOLENOID, SINGLE PILOT
DOUBLE PILOT, LEVER
OR BALL ACTUATED



ONLY 1″ THICK BY 3″ WIDE

Compact, light in weight, and easily manifolded, these new Hunt valves have been designed specially for use when mounting space is limited. Ideally suited for controlling small cylinders, or to operate diaphragms, pilot cylinders or other devices. Pressures to 125 psi.

Proven, dependable Hunt construction, with hollow, radially ported stainless steel plunger; and "O"-ring seals accurately positioned with metal spacers, held rigidly in metal to metal end abutment. No lapped joints and no rubbing of metal against metal to cause wear, assuring long, efficient, maintenance-free operation.

Easily manifolded. The side of each valve is counterbored; trepanned for an "O"-ring and provided with four through holes. This permits up to eight valves to be manifolded together in any of four 90° angle positions, and operated simultaneously from a single supply;— or up to sixteen valves from two supply sources.

More startling HUNT designs to come!

Send for the "SLIM LINE" Bulletin No. 581 TODAY!

HUNT

Quick-As-Wink*® AIR AND HYDRAULIC CONTROL *Valves

Manufactured by HUNT VALVE COMPANY, 2072 East Pershing St., Salem, Ohio

Circle 655 on Page 155

NOVEMBER 1958
Vol. 5—No. 11

AUTOMATION

A PENTON PUBLICATION

The Magazine of Automatic Operations

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REGULAR DEPARTMENTS

Automation Outlook, 4
Automation News, 9
Meetings and Events, 28
Detroit Dateline, 31
Western Trends, 37
New Equipment, 87
New Components, 107
Abstracts, 135
Books, 144
Editorial Index, 148
Patents, 150
Advertising Index, 151
New Literature, 153
Equipment Index, 155
Readers' Reply Card, 155

Selling Solutions, 41
EDITORIAL—progress can best be served if machine builders recognize their primary role is that of manufacturing engineering.

Using Data Reduction, 42
W. E. CHOPE—timely information is an important factor in obtaining optimum results from automatic production systems.

Making Refrigerator Cabinets, 47
V. C. RICE—pictorial review of major production facility that was created to hold the cost line in competitive appliance field.

Mail Processing, 52
EQUIPMENT HIGHLIGHTS—modernization program has resulted in development of unique machines to speed mail handling.

Counteracting Voltage Dips, 60
G. W. HEUMANN—examination of techniques and equipment for achieving continuity of electrical service in vital power and control setups.

Handling Device Automates Forging Press, 66
INTEGRAL UNIT—hot steel bars advance through die stations in production of track links for tractors.

Meter-Relay Control, 67
GRINDING PROCESS—unit corrects position of motor-driven workholding fixture in bearing ball production process.

Testing Hardness Automatically, 69
V. E. LYSAGHT—equipment developments have extended range of application of what was once considered only a laboratory device.

Special Evaporation Plater, 72
KENNETH LI DONNICCI—continuing program results in additional equipment to speed production of units critical to defense efforts.

Building-Block Controls, 75
W. C. LEONE—discussion of concept which provides an economical solution to the problem of obtaining custom controls.

Director Center for Tape Control Users, 81
CO-OPERATIVE VENTURE—aircraft companies share single processing facility that prepares magnetic tape for numerical control.

Indexing Machine Assembles Armature Cores, 82
MULTISTATION UNIT—preformed laminations assembled to shaft in manufacture of automotive heater motor part.

Continuous Radiation Processing, 84
CONVEYORIZED SYSTEM—process facility made possible by automatic handling of parts to be irradiated.

automation outlook

EMPLOYMENT STABILIZER

". . . far from throwing men out of work, automation is our main hope today in some industrial areas for keeping men employed at high wages. Without the use of cost-cutting automation we have little hope of controlling or lowering final costs to a point where more people can buy the products we make. Correctly applied, automation enables us to absorb the cost of our vastly increased production capacity without reducing wages . . ."—*Chester S. Johns, Buhr Machine Tool Co.*

WORK SATISFACTION

". . . we are now in a fullness of automatic machinery, instrument control, and systems engineering. In this achievement, drudgery is diminished, working hours are shortened, men are more secure in their jobs, but this achievement has been attained through a system we call mass production, a system by which much of the work satisfaction of the craftsman has been taken away. I am hopeful of a prospect that under automation some of this work satisfaction can be restored . . ."—*Ted F. Silvey, AFL-CIO Headquarters, Washington, D. C.*

NO TECHNICAL OBSTACLES

". . . in the wholesaling field, fully automatic warehouses will most probably dominate tomorrow's food distribution picture. Actually, designers today see no technical obstacles to pushbutton warehouses. They claim that they have all of the material available now. . ."—*Nathan Cummings, chairman of the board, Consolidated Foods Corp.*

OFFICE AUTOMATION

". . . timely information more and more has become an important influence to the continued successful operation of modern business. This need, coupled with the fact of personnel shortage, both quantitatively and qualitatively, has created the setting for automation of office procedures. . ."—*Frank J. Kovac, assoc. dir., Public Relations, Standard Oil Co. of Ohio.*

DEPRECIATION POLICIES HIT

". . . the recession in the machine tool industry will be over only when users and purchasers of machine tools are convinced they can once more recoup their original investments in a reasonably short period of time. Companies simply cannot go on overpaying their taxes every year because of inadequate depreciation, or they will wind up in general liquidation . . ." —*A. V. Bodine, president, National Machine Tool Builders' Association.*

DOING WHAT COMES NATURALLY

". . . we can expect in the future to see many factories in which the heart is a computer whirling away and blinking its lights, as a result of which machines are continually changing operating conditions and making different products from time to time, with no apparent external signals. These shops and the computers that direct them will almost look as if they are thinking for themselves. Actually, of course, they do no more thinking than a sewing machine. The illusion is created by the speed of calculation, but in reality all that the machines and the computer are doing is exactly what they were told to do in the first place . . ."—*E. Duer Reeves, executive vice president, Esso Research & Engineering Co.*

AUTOMATION

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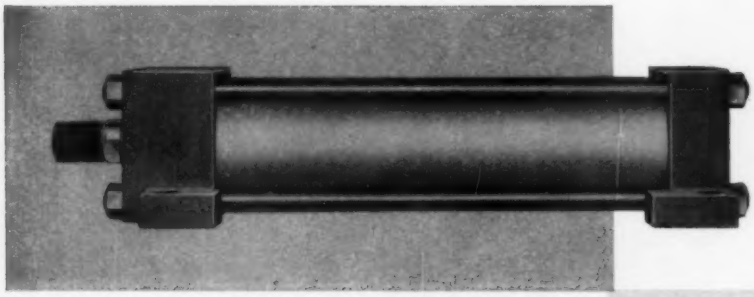
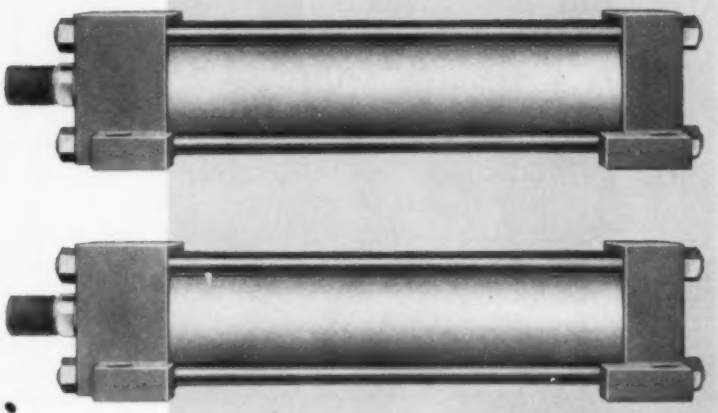


A LOGAN SUPER-MATIC CYLINDER

2 competitors' cylinders

do they LOOK ALIKE? ...sure they do on the surface...



Logan Super-Matic Cylinders

are made to interchange with other leading manufacturers' cylinders . . .

...BUT LOOK AT Logan's BIG EXTRA PLUS VALUES

1. Logan designs assure the service required for those extra-rugged applications.
2. Over FORTY YEARS of cylinder manufacturing know-how.
3. Built by CRAFTSMEN whose average service record with LOGAN is more than 20 years.
4. Manufactured in a plant which applies the most modern production methods.

FREE

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- ☐ 100-4 AIR VALVES
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COMPANY_____

ADDRESS_____

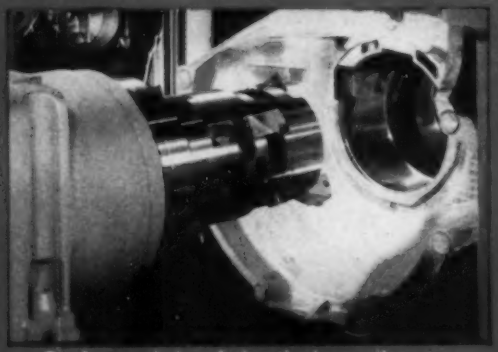
Circle 656 on Page 155

Cincinnati 26-Station

Mills, Drills, Bores . . .
Ford Automatic Transmission Cases

Transmission cases require gentle handling; firm, balanced clamping; experienced machining. All these requirements are incorporated in the CINCINNATI 26-Station Unit Type Transfer Machine illustrated at the right. This production line mills, drills and bores Ford automatic transmission cases; inserts two bushings; automatically banks excess parts; transfers the casting from one station to the next. There are 26 stations, allocated as follows: 10 for machining, one for inserting bushings, one for banking, one for future engineering changes, and the remainder for other functions required in a modern transfer line. Several outstanding advantages are incorporated in this line, including unit construction and complete static electrical control. ¶Cincinnati builds special machine tools and complete production lines varying in complexity from small bearing-shell broaching machines to giant production lines performing a multitude of operations. Make Cincinnati your first choice for equipment of this type. The Special Machine Division is ready to serve you.

Rough milling the pan face, station 2. This is the first machining operation on the transmission line.



Boring and chamfering the large diameter. At the same time, boring and facing operations are performed from the other end. Station 8.

CINCINNATI®

Special Machine Tools · Vertical and Horizontal

Unit Type Transfer Line

Inside the transmission case. Hard-to-reach surfaces are easily machined on the CINCINNATI Transfer Line.

At Ford Motor Company's new plant in Sharonville, Ohio, automatic transmission cases are automatically bored, milled and drilled in 33 machining operations on this CINCINNATI 26-Station Transfer Line. Accuracy and finish are excellent. The machine cycles 137 times per hour.

CINCINNATI

Broaching Machines · Complete Production Lines

Special Machine Division
THE CINCINNATI MILLING MACHINE CO.
CINCINNATI 9, OHIO

Circle 657 on Page 155

ERIEZ

MAGNA-RAIL UNITS SPEED UP CONVEYOR LINES, CONSERVE VALUABLE FLOOR SPACE!

Small, lifetime-powered magnetic automation elements fastened under conveyor belts provide safe, positive hold for ferrous parts; swiftly convey, control and elevate up inclines as steep as 80°; increase safety conditions and reduce damaged parts.

NEW DESIGN FOR GREATER EFFICIENCY! Magna-Rail sections enclosed in a sturdy, extruded aluminum housing are now available. Prevents tampering with magnetic elements; assures ultimate magnetic strength at all times; greatly increases the physical strength of the unit. It's another *first* from Eriez—*always first* in magnetic research and design!

Speed up production and reduce operating costs with Eriez Magna-Rail! These units, fastened under existing lines or incorporated into new ones, turn ordinary belt conveyors into **magnetic** conveyor-elevators that are able to move ferrous materials and parts at greatly increased speeds.

Powerful magnetic action of Magna-Rails holds items such as nails, caps, cans, stampings, scrap, finished parts, etc. at fast speeds even up (or down) inclines as steep as 80°. Convey on both top and bottom sides of your lines . . . automatically turn conveyed parts over . . . change direction of flow, etc. Use of steeply inclined conveyor lines shortens belt lines, permits machines to be more closely grouped together. Positive hold prevents items from slipping off the line; improves safety conditions, reduces damaged parts.

Magna-Rail is a 4" wide assembly, standard lengths from 3' to 6', containing a series of Alnico V non-electric magnets. The unit is available in straight or curved sections for direction change of a conveyor line. Magna-Rail will **automatically** convey, control or elevate material from one machine (or operation) to another, with automatic discharge where required. When used with other Eriez HI-POWR magnetic equipment, these units offer unlimited automation advantages.

Lightweight and simple in design, Magna-Rails are easily incorporated into present conveyor lines. No outside power is needed, and maintenance is nil. Magnetic strength is guaranteed indefinitely.

• • • • • • • •

Eriez does not design, build or sell material-handling systems, *but we serve people who do* in areas where magnetic equipment should be incorporated. We willingly share the design-and field-application know-how gained through helping others move materials faster, more economically, more efficiently and more accurately by utilizing the inherent advantages of magnetism. Specifically, we produce standard lines of magnetic equipment and, in addition, design and build special components to *magnetically* convey, transfer, control, elevate, re-position, hold or re-orient basic ferrous material or finished parts. As our engineers work very closely with both system manufacturer and ultimate user, the most efficient installation is the end result.

ERIEZ MAGNA-RAIL UNITS PROVIDE THESE IMPORTANT AUTOMATION ADVANTAGES:

• Magnetic strength is guaranteed indefinitely; first cost is the only cost • Completely non-electric; no wires or attachments • Easily incorporated into new or existing equipment • Virtually no maintenance; magnets are trouble-free • Compact size: 4" wide, $1\frac{15}{16}$" high. Standard sizes are 3, 4, 5, 6 ft. (special sizes made to order) • Safe, positive hold • Permits faster conveyor speeds in less space • Lightweight; simple design • Eliminates manual handling, reduces damaged parts • Conveys up inclines as steep as 80° • Many magnetic strengths

Produced under Patent 2, 551,947.

***BIG, NEW BULLETIN** on magnets for automation.*
For your free copy, write:

ERIEZ Manufacturing Company
119-L Magnet Drive, Erie, Pa.

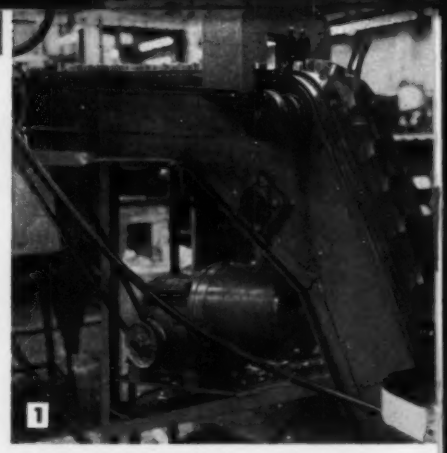
ERIEZ HI-POWR MAGNETS FOR AUTOMATION

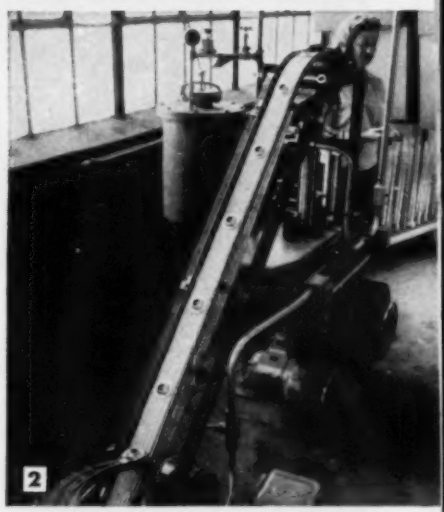
PIONEERS AND WORLD'S LARGEST PRODUCERS OF PERMANENT NON-ELECTRIC MAGNETIC EQUIPMENT AND NEW HI-VI ELECTRO PERMANENT MAGNETIC VIBRATORY EQUIPMENT

MAGNA-RAIL SOLVED THESE CONVEYING PROBLEMS:

1. **Cleveland Graphite Bronze Division, Clevite Corp.** Problem: to secure bushings and bearings to a conveyor belt without marring their close tolerances and mirror finish by sudden belt stops or inclines. Solution: MAGNA-RAIL
2. **Sherwin Williams Company.** Problem: to convey paint can tops more quickly without having them slide off the line and to discharge them automatically at the rate of about 100 per minute. Solution: MAGNA-RAIL
3. **R. T. French Company.** Problem: to elevate caps for mustard jars up a steep incline, over a conveyor line, and automatically release them into the hopper of a capping machine. Solution: MAGNA-RAIL
4. **National Can Company.** Problem: to convey can ends at the rate of 200 per minute from a press to a coater, without danger of the ends sliding off the line at this rate of feed. Solution: MAGNA-RAIL

Circle 658 on Page 155





AUTOMATION news

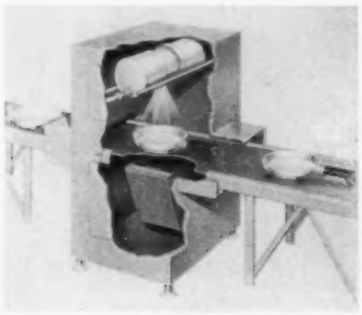
Today's events and developments in the field of automation

Television X-Ray Allows Conveyor Line Inspection

CONTINUOUS internal inspection of concealed product parts is now possible with a new x-ray image intensification system developed by the X-Ray Dept., General Electric Co. Comparable to closed-circuit television, the new TVX system permits economical 100 per cent visual inspection of material traveling on a conveyor belt.

Three basic units compose the x-ray system—an x-ray sensitive camera, a control unit, and a viewing monitor. The camera uses a new x-ray sensitive tube which allows direct transfer of x-ray energy to electron energy capable of being displayed on the monitor. In a production line, materials to be inspected are conveyed between an x-ray source and the x-ray camera. The x-ray source produces electromagnetic waves which penetrate the material. Dense parts of the material will absorb the x-radiation while less dense parts will allow the rays to pass completely through. These rays impinge on an aluminum plate coated with lead monoxide in the camera tube. The lead monoxide acts as a semiconductor and loses its charge in a ratio to which the x-ray fell upon it. An electron beam then scans the plate, and picks up x-ray intelligence which is transmitted to the control unit and translated from an electrical image to a visual image on the viewing monitor.

X-RAY IMAGE of heating element terminals and thermostat assembly of an electric frypan appear on the 12-inch screen of the viewing monitor during continuous inspection with General Electric Co.'s television x-ray system. Image size can be varied from ½ to 3 times the size of the x-rayed object by control unit beneath monitor. System allows product inspection viewing up to 1400 feet distance from conveyor line and x-ray source.



DRAWING illustrates a typical production line setup for continuous inspection of internal elements in an electric frypan. Conveyor carries the frypan between the upper x-ray source and the lower x-ray camera which transmits image to viewing monitor. The units are enclosed in a shielded cabinet for protection of personnel.

The viewing monitor provides the inspector with an image size which is electronically variable from ½ to 3 times that of the original object. Unlike ordinary fluoroscopic inspection which requires the inspector to work in a darkened room or area under conditions that create eye strain and radiation hazard, the television image is clear and bright and can be viewed in normally lighted areas. Since the monitor can be placed up to 1400 feet from the x-ray production line, any x-ray intensity necessary for adequate penetration can be used without radiation hazard to the inspector.

At the present time the x-ray system is being tested in various industries. The aircraft industry is using the system to inspect internal parts of propellers. A unit is being used in the electronics industry to inspect potted components. An electric frypan manufacturer is inspecting internal heating elements, and the Atomic Energy Commission is using the x-ray system to inspect canned fuel elements.

Although x-ray inspection techniques have been available to industry for many years, the television x-ray system is one of the first which allows continuous inspection on a moving production

line. Inspection by x-ray film requires approximately 45 minutes to get a dry viewable film. Another industrial process called Xeroradiography is similar to the film process except the data are recorded on a sensitized plate. However, this system requires parts to be removed from a conveyor line for exposure and takes about a minute for processing the plate. Other systems record data presented on fluorescent screens, but these systems involve a number of changes of energy forms and can introduce noise into the x-ray intelligence. The television x-ray system allows continuous product inspection at conveyor speeds of 10 feet per minute with direct translation from x-ray energy to electron energy for instantaneous display on a viewing tube.

AUTOMATION Study Shows Vast Market for Automatic Equipment

AMERICAN INDUSTRY will spend an anticipated $5 billion to automate its manufacturing and data processing facilities during 1959, according to a recently completed study of 17,000 industrial plants conducted by AUTOMATION magazine.

Small, medium, and large-lot production plants will participate in the growing trend toward more automatic production. Small-lot producers will spend $650 million, medium-lot producers $1.3 billion, and large-lot producers $3 billion.

Roger W. Bolz, editor of AUTOMATION, indicates that 94 per cent of all plants reporting listed cost reduction as their prime reason for automating. Other important reasons were increased production requirements, improved quality, eliminating scrap losses, and overcoming labor shortages.

"One point of particular significance," says Mr. Bolz, "is that just eighteen months ago the primary reason for most plant automation was increased production requirements. The recession, apparently, has made American industry more cost conscious."

Industrial buyers looking for more automatic production techniques will spend approximately $800 million for automatic handling equipment, $500 million for machine tools, $1 billion for special automatic equipment, and $900 million for process machinery.

Automatic controls for industrial use will also see much activity at the buyers' market with $430 million earmarked for instruments, $115 million for electronic controls, $750 million for electric controls, and $500 million for pneumatic and hydraulic controls. These figures do not include the billions that will be spent for military control systems.

Joint Study To Investigate Computer Control Of Refineries

CO - OPERATIVE development study concerning the application of digital computers to automatic process control will be jointly conducted by the Standard Oil Co. of Ohio and the Thompson-Ramo-Wooldridge Products Co. In announcing the new study, E. N. Marsh, chief of Sohio's Process Engineering Div., said that its purpose will be to explore new automation techniques for the control of refinery units.

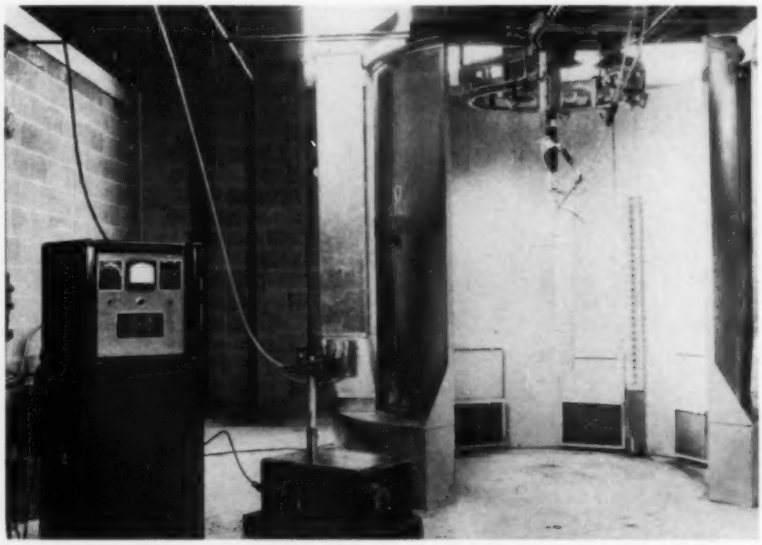
The joint study will be based on a "systems engineering" approach to process optimization. It is expected the new control techniques and equipment to meet control requirements will be developed through the study.

Upturn Gains Momentum As Capital Spending Increases

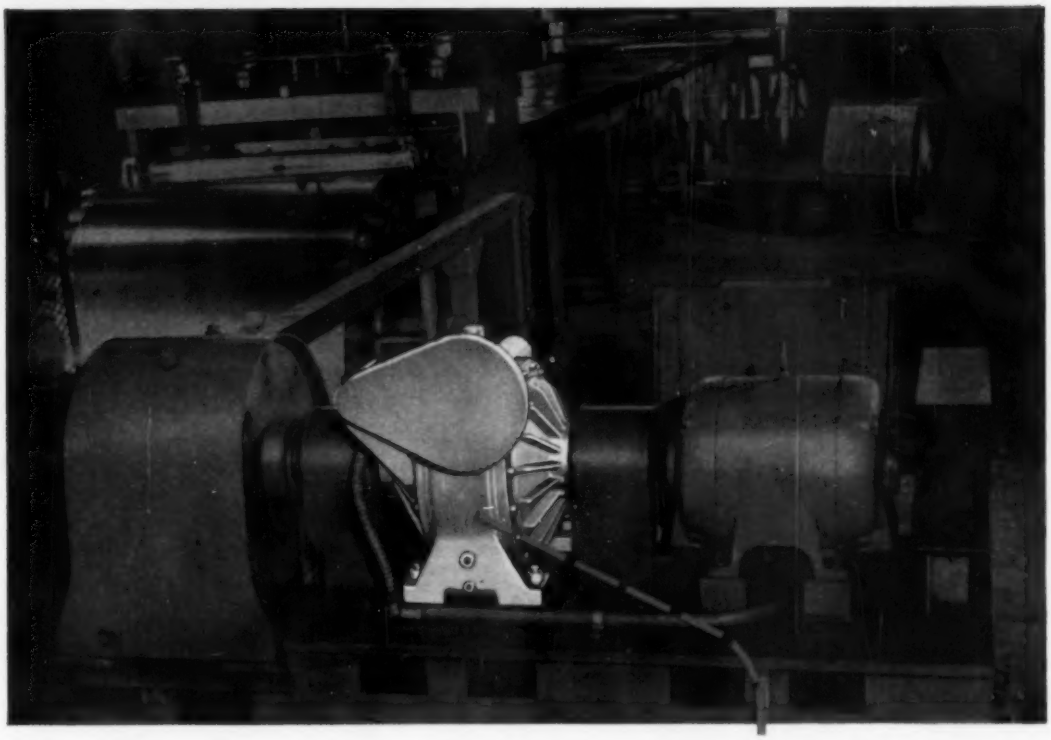
UPTREND in business still seems to be gathering strength according to the latest review of current economic conditions by the Guaranty Trust Co. of New York. The uptrend now appears to have good promise of continuing for an extended period of time.

Indications are that the gain is broadly diversified as to origin, reflecting higher consumer outlays, higher construction expenditures, slower rate of inventory liquidation, and additional spending by government units. Capital spending by business declined during the third quarter, but much less than in previous quarters.

Most reassuring development was the disclosure by the government of a survey which indicated that the decline in capital spending may be



FLEXIBILITY of electrostatic spray painting equipment can be shown to customers in any one of sixteen demonstration laboratories built into Ransburg Electro-Coating Corp.'s new plant in Indianapolis. The laboratory facilities simulate actual production layouts and contain different types of conveying units for moving test parts past the electrostatic spray devices. In the test booth shown, fluorescent lighting fixtures are conveyed past a reciprocating disk spray painting unit. A strong electrostatic field is created between the atomizer and the article to be painted. Force of this field transforms the coating material into a spray of fine charged particles which are attracted to the grounded article on the conveyor. Electrostatic painting reduces paint waste from overspray and improves quality of work.



Processing line speed control no problem . . . thanks to Cleveland Speed Variator

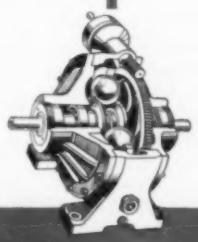
At Armco Steel's Middletown Works, one rugged 7K6 Cleveland Speed Variator provides infinitely variable speed progressions for one of their many steel processing lines.

This electrically remote-controlled unit is shown driving the line's conveyor pay-off reel station. All Clevelands feature simple, precise construction which makes for a compact, quiet-running, instantly-adjusted drive.

If variable speed drives are indicated on your production processes, then Clevelands are the logical choice. Write today for illustrated Bulletin K-200 for complete specifications, sectional drawings and rating tables on the full line of Cleveland Speed Variators.

The Cleveland Worm & Gear Company, Speed Variator Division, 3265 East 80th St., Cleveland 4, Ohio.

Sales representatives in all major industrial markets.
In Canada: Peacock Brothers Limited.



HOW IT WORKS

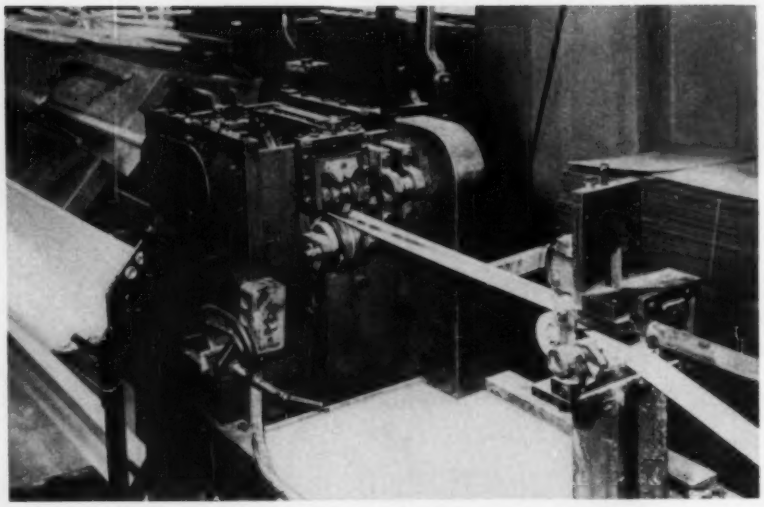
Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the axles on which the balls rotate (see cutaway view, right).

CLEVELAND SPEED VARIATOR

Circle 659 on Page 155

already over and that a modest uptrend may become apparent before the end of the year. Prior to this survey, it had been assumed that outlays for plant and equipment would continue to decline well into 1959 and act as a drag on recovery. If a reversal does materialize, it will indicate that the problem of excess capacity may have been exaggerated.

Index of industrial production also points to a rapid recovery from the recession. Since last April, it has recovered approximately half the setback suffered in the downturn. All these favorable factors add up to a continued extension of the recovery movement. If consumer interest in durables should also be renewed, the pace of revival could be surprisingly brisk. It already seems reasonable to anticipate the gross national product will regain its previous peak of $445.6 billion by the end of this year or early in 1959.



CORNER BEADS for dry wall construction are produced at a rate of 5700 linear feet per hour in an automatic process at Beadex Corp. The corner beads consist of an aluminum strip formed to an angle of 90 degrees and faced with an adhesive bonded paper. In a continuous process, flat aluminum strip is first washed, dried, and drawn through rolls to form a 90-degree angle. At the same time a paper strip is cleaned of lint and fuzz and passed through an adhesive applicator which deposits a uniform film of Minnesota Mining and Mfg. Co.'s adhesive. The aluminum angle and adhesive-coated paper are then combined and passed through a second series of rolls which bond and form the paper to the aluminum angle. A final operation automatically cuts the finished strip to predetermined lengths which are self-stacking for packaging.

Glass Sealing Method Provides High Production

DEVELOPMENT of a new method of flameless sealing of glass to glass in the manufacture of capsulated transistors and rectifiers has been announced by S. **Irving Weiss**, president of Trans-Sil Corp. "The most outstanding characteristic of our new development," Weiss said, "is its ability to effect an 80 per cent savings in production costs."

The new process incorporates the use of a metal ring inserted in powdered glass. An induction coil heats the metal ring, causing the glass to flow and to create an air-tight seal. Done on a continuous sealing machine, it is estimated that 1000 units per hour can be sealed. Previous encapsulating techniques incorporated the use of metal bases and caps sealed by means of welding the two parts together, and the reject rate was very high.

According to Weiss, the new process eliminates the possibility of contamination during the sealing of rectifiers and transistors. It provides a means of consistent hermetic sealing, permitting sealing in a vacuum or an inert atmosphere. As a result, service life and performance of the components are appreciably increased.

Lubrication Alarm Device Protects Force-Feed Systems

LOW-COST device for providing positive protection against interruption of lubricant flow to compressors, engines, and other machinery has been announced by Manzel, Div., Houdaille Industries Inc. The new product, called Lube-Line Alert, measures $3\frac{5}{8}$ x $1\frac{1}{2}$ x 1 inches, and is designed to be installed in force-feed lubrication systems adjacent to each terminal point of the lubrication feeders. If the flow of lubricant to the terminal point is interrupted for any reason, an electrical switch in the unit is closed actuating any desired audio, visual, or mechanical warning device.

The protective device consists of a stainless steel body, a plunger and a spring, a free-moving magnet, and a magnetically-actuated switch. Oils or synthetics flowing through a cross port in the unit move the plunger and magnet. If the flow of lubricant is broken, the plunger and magnet return to their origi-

Third Automation Conference Planned For Spring, 1959

CONTINUING the series of technical programs begun 2 years ago, the Third Conference On Manufacturing Automation will be held at Purdue University on March 23-25, 1959. Co-sponsored by the Schools of Mechanical Engineering and Industrial Engineering of Purdue University and the editors of AUTOMATION, the conference meeting date has been advanced from Fall to Spring at the suggestion of the Planning Committee and of many participants in previous sessions. Details of the conference program will be announced early in 1959.

from Skinner in '58

...these answers to your control "puzzles"

L **NEW two-way valve for high flow industrial applications**

At greatly reduced cost, this larger pilot-operated valve permits applications not possible before. Designed for air, oil, water. Features ½" orifice with ⅜" or ½" NPT ports, ¾" orifice with ¾" NPT ports, 1" orifice with 1" NPT ports. Pressure differentials: 5-150 psi. Body is naval forged brass. Diaphragm is fully supported. Available in standard and Explosionproof construction, normally open or normally closed.

A **NEW three-way valve for medium-sized cylinders**

Available normally open, normally closed, directional control and multi-directional, with 5/32" inlet and 5/32" exhaust orifices and ¼" NPT ports. Designed to control air, oil and inert gases. Handles pressures to 125 psi. Body is non-corrosive zinc. Internal parts are stainless steel.

LC **NEW two-way, low-cost, pilot-operated valve**

A smaller, lighter, normally closed valve. Permits full flow through ½" orifice with ⅜" or ½" NPT ports. Will control all common media: air, oil, water, etc. Pressure differentials: 5-150 psi. Forged naval brass body. Uniquely designed diaphragm – fully supported.

R **NEW two-way valve for standard and high pressure applications**

A big capacity, pilot-operated valve with a ¼" orifice and ¼" NPT ports. Designed to control air, water, oil, semi-corrosive materials. Long-lasting, stainless steel internal parts. Forged naval brass body. Available normally open or normally closed. Standard models operate on pressure differentials of 5-200 psi; high pressure normally closed models on 5-1250 psi.

For complete information, please contact our Representative or Distributor near you . . . you'll find him listed in the yellow pages or write us at the address below, Department 32N.

SKINNER ELECTRIC VALVES
THE CREST OF QUALITY

SKINNER ELECTRIC VALVE DIVISION
NEW BRITAIN CONNECTICUT
105 EDGEWOOD AVENUE

Circle 660 on Page 155

nal positions, actuate the switch, and cause the alarm device connected to the switch to signal no-flow.

Standard units are usable with any viscosity oil or synthetic lubricant for pressures up to 10,000 psi. Explosion-proof units are also available.

Typewriter for Scientists

DUAL-KEYBOARD machine for typing scientific and mathematical formulae has been developed by a British company, Imperial Typewriter Co. Ltd. The novel machine uses two keyboards having a total of 180 characters. The keyboards are synchronized so that the scientific symbols typed by one fall accurately into place on the script typed by the other. The machine is currently in use at Britain's Atomic Research Station at Harwell.

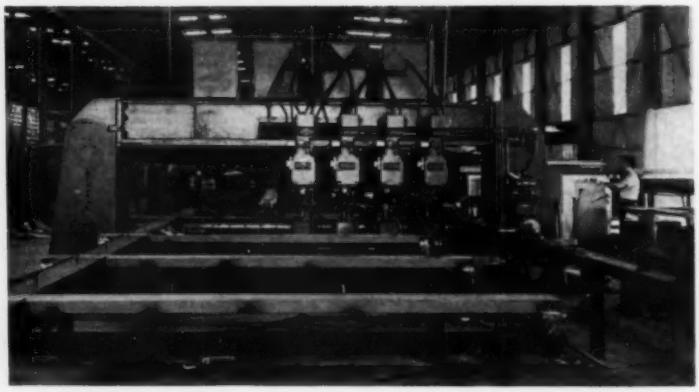
Industrial Engineering Research Abstracts Published By AIIE

RESEARCH performed in the field of industrial engineering during the period between July 1952 and July 1957 has been published in series of abstracts by the American Institute of Industrial Engineers. Ultimate objective of the AIIE Research Information Committee is to obtain a complete compilation of all industrial engineering research work so that it might be used by industry and universities to solve practical problems.

A second survey covering research completed between July 1947 and July 1952 is underway, and the committee is seeking research abstracts of work performed during this period. Questions about the project and contributions of material should be sent to the committee in care of the Dept. of Industrial Engineering, Washington University, St. Louis 5, Mo.

Multicolor Spray Systems

MULTICOLOR electrostatic spray system for producing both single



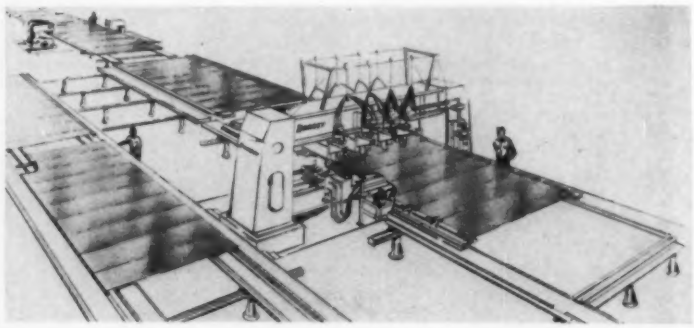
Trailer Manufacturer Uses Automatic Riveters To Speed Production

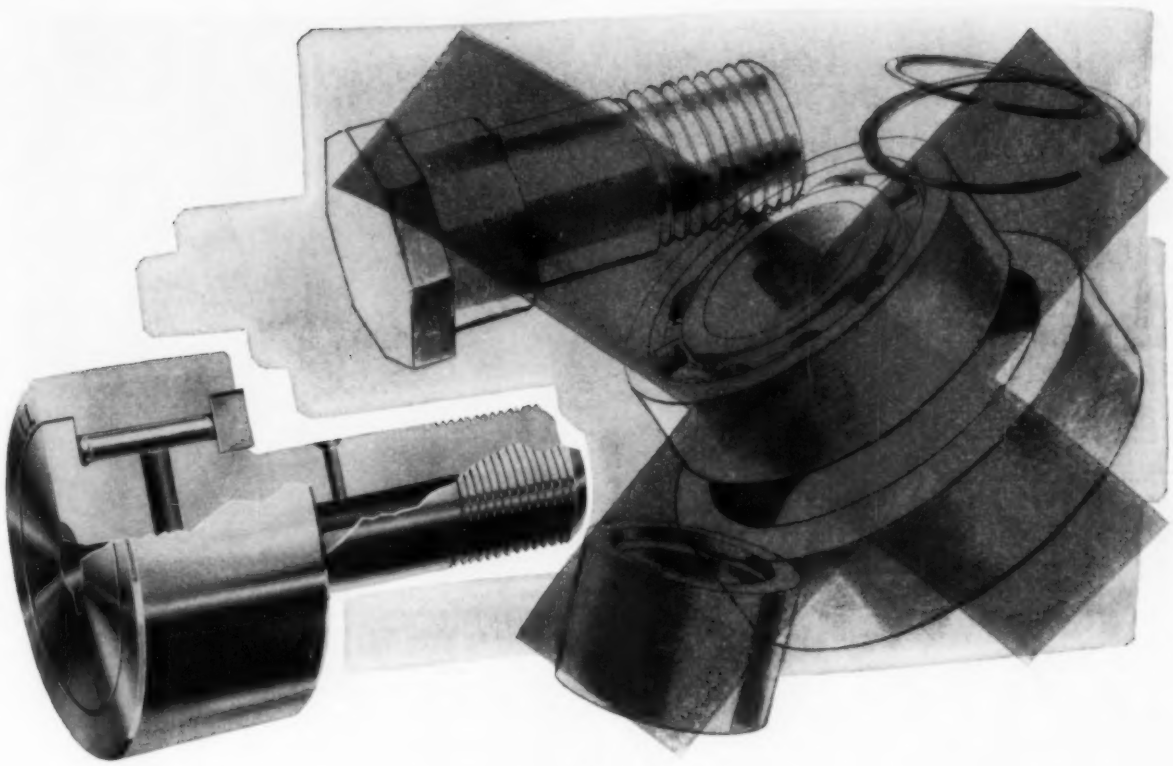
AUTOMATION has entered the field of trailer and truck body manufacture with the installation of an electronically-controlled riveting machine on an assembly line at Dorsey Trailers Inc. The new machine drills a rivet hole, inserts a rivet, and upsets the bottom of the rivet for over 6000 rivets in a trailer's sides, front, and roof in less than one hour. Uniformity of rivet spacing as well as secure joints result from the automatic riveting operation.

According to **J. V. Wright**, Dorsey president, the equipment required over two years of development work by the company's engineers and General Riveters Inc. Similar equipment is used by aircraft manufacturers, but Dorsey Trailers is the first to adapt the method to building trailers. The trailer installation involved the adaptation of automatic riveters to a bridge-type structure large enough to handle an entire van side as a complete unit. The machine has four riveting heads and is the first multiple unit produced by General Riveters.

Aluminum sheets and stiffeners for a complete trailer side are first assembled in a frame which then moves on a table through the riveting machine. The machine starts drilling, inserting, and riveting at one panel corner, moves down one transverse row of rivets, jumps to the next row, and returns to the starting side. This transverse riveting continues for the entire panel. With all four heads operating, the machine installs 80 rivets a minute. Electronic controls activated by a template guide the operation.

One advantage of the automatic riveter is the reduced noise level as compared to 40 hand riveters doing the same amount of work. Instead of pounding the rivet to upset the end, the machine uses a hydraulically-powered ram which sets the bottom of the rivet with a squeezing action while the head is held by a bucking anvil. This pressure also tightens the rivet in the hole and produces tighter and stronger joints. The automatic unit can also be used to rivet steel panels.





McGILL® CF *CAMROL*® bearings

eliminate the cost of producing and assembling improvised cam follower, track and guide roller units

THESE CAMROL ADVANTAGES SOLVE COST, DESIGN, PRODUCTION AND PERFORMANCE PROBLEMS:

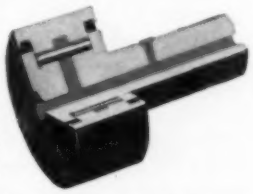
• AVAILABILITY • INTEGRAL UNIT CONSTRUCTION • HIGH LOAD CAPACITY • SMALL RADIAL SPACE REQUIREMENTS • HIGH SHOCK RESISTANCE • PRECISION ACCURACY • SIMPLIFIED LUBRICATION

You can simplify design and cut cost with CAMROL, precision cam followers. Procurement, production and assembly of components for improvised units are eliminated when you specify CAMROL bearings that are available from stock.

McGill developed the original roller bearing cam follower and perfected the CAMROL design through 25 years of application experience. Its full type construction provides exceptionally high capacity in an integral unit of a flanged, specially heat treated stud and heavy shock resistant outer race. Grease lubrication is simplified. Plain bearings require constant oil lubrication and bolt mounted ball bearings races crack under equivalent loads.

Precision construction, including concentricity of stud to outer race OD, provides accurate alignment of machine members. Ease of interchangeability and dependable operation in any cam action, track, guide or support roller application is assured. Use the CYR series in the same roller diameters for shaft mounting.

PRE-LUBRICATED SEALED CAMROL BEARINGS



These bearings combine the advantages of CF and CYR series bearings plus effective sealing against dirt, dust and grit. Ideal in applications where lubrication is a problem. Black ferrous oxide finish resists corrosion in contaminated areas.

CAMROL bearings are available in standard roller diameters from ½" to 4". Capacities to 20480 lbs. at 100 RPM.

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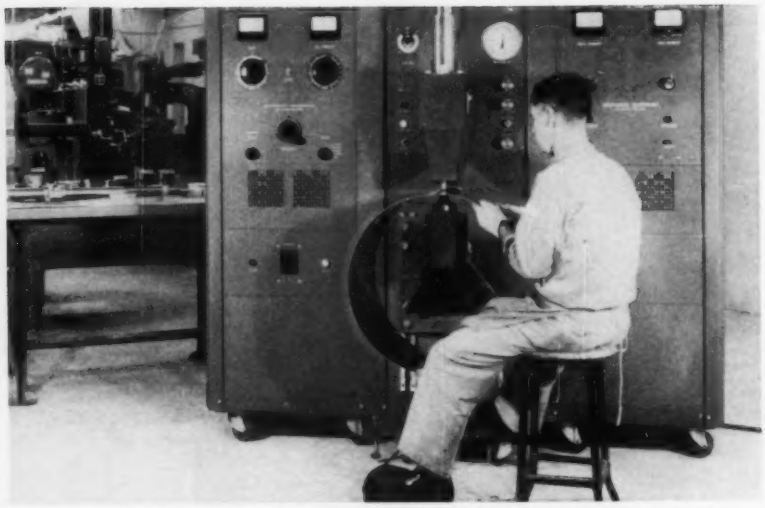
McGILL®

precision needle roller bearings

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 401 N. LAFAYETTE ST., VALPARAISO, INDIANA

Circle 661 on Page 155

color and mixed color patterns or finishes has been developed by Ionic Electrostatic Corp. The system utilizes an array of variable speed electrostatically charged centrifugal atomizers which blend coating materials to produce various types of multicolor mixed patterns. Reciprocating or stationary models are available.



ULTRASONIC spot-type welder has been developed by Aeroprojects Inc. and will be marketed through its subsidiary, Sonobond Corp. Ultrasonic welding is a solid state joining process in which the materials to be joined are subjected to high frequency alternating vibrations. The resulting joints are accomplished without fusion and in many materials exceed the strength of similar joints made by resistance welding methods. Outstanding feature of the welding technique lies in its ability to join dissimilar metals and alloys and to weld thin gages of materials. Welder shown consumes a maximum of 3.5 kva of power when joining 0.050-inch aluminum sheet (1100-H14). Ultrasonic welding requires considerably less electrical power than resistance welding and can be operated on a 230-volt circuit.

Solid State Electronic Control Instruments Offered By Foxboro

NEW LINE of solid state electronic control instruments using magnetic amplifiers and transistors in place of vacuum tubes has been introduced by Foxboro Co. Called Electronic Consotrol Instrumentation, the new series consists of transmitters, recorders, controllers, and valve operators which can be applied in a process control loop.

Two types of transmitters—force balance or motion balance—are available in the new line. Either type can be used for field measurement or remote transmission of pressure, flow, liquid level, temperature, and other variables to a central control panel. Sensing devices, measuring these quantities, send low voltage emf or resistance electrical signals to a transducer in the transmitter which converts them to proportional high level current to actuate recorder-controller units in the control panel. Magnetic amplifiers can also be provided in the transmitter if the rectified output of the transducer is not high enough to operate the receiving units. The emf-to-current converter is used on measurements such as pH, power, and speed while the resistance-to-current converter handles measurements of temperature, temperature difference, and others.

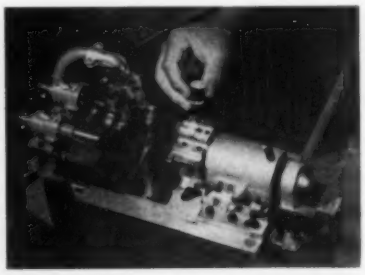
The new recorders occupy only 6 by 6 inch area in the control panel. They are available with one or two pens and use 4-inch wide strip charts. A deflection motor operates directly from the transmitted measurement signal to drive the recorder pen. The motor consists of a permanent magnet surrounded by a closed iron loop. A moving coil, energized by the transmitted signal, is mounted on a flexure-pivoted frame and travels the slight gap between the magnet and loop. Current in the coil, interacting with the magnetic field, produces a force on the frame which positions the pen. An adjustable liquid dashpot is provided to reduce undesirable "noise" at the pen. Since the deflection motor is an averaging device, damping provides a true average measurement.

The solid state controllers occupy 3 by 6 inch area in the con-

Automation Recognized As Keynote of Manufacturing

AUTOMATION requires the close co-ordination of all groups responsible for the design of the finished product and the machinery and equipment to make the finished product. Recognizing this fact, CBS-Hytron, Div., Columbia Broadcasting System Inc., has consolidated its mechanical and electronic equipment design, development, and production facilities for receiving tube operations at a new plant in Newburyport, Mass. The firm's mechanical and electronic equipment departments were formerly scattered in several locations.

According to **M. C. Callahan**, vice president and general manager —receiving tube operations, "The keynote of our manufacturing today is automation. The combining and

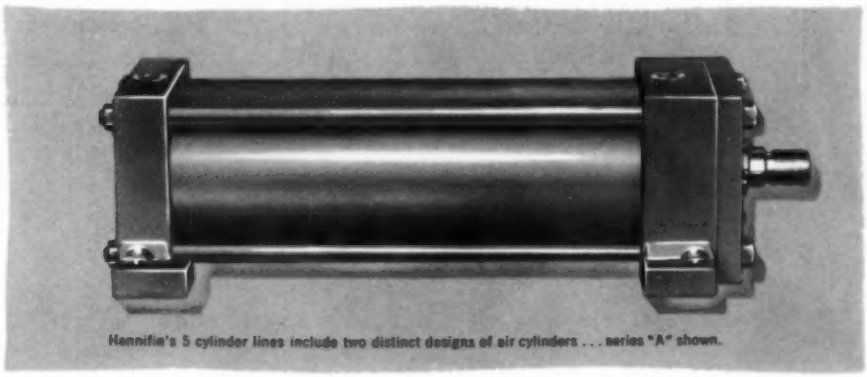


streamlining of our equipment operations has been an important step in maintaining efficient operations. Much of CBS-Hytron's automatic production and test equipment is being designed and constructed at Newburyport."

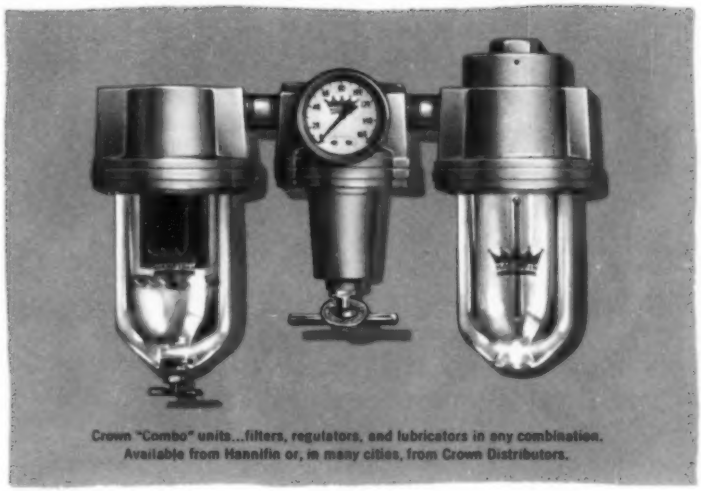
The accompanying photograph shows one of the compact electron tube automatic assembly units which was designed and built at the new plant.

Circle 840 on Page 155→

PARKER-HANNIFIN FLUID-SYSTEM COMPONENTS



Hannifin's 5 cylinder lines include two distinct designs of air cylinders . . . series "A" shown.



Crown "Combo" units...filters, regulators, and lubricators in any combination. Available from Hannifin or, in many cities, from Crown Distributors.

Only **HANNIFIN** makes all these **AIR POWER COMPONENTS**

Hannifin valves take many forms. This ⅜" 4-way valve out-performs many a competing ½" valve.

Anywhere you use compressed air to do work, Hannifin can help you. Hannifin cylinders for the "muscles". . . Hannifin air valves for any type of actuation, hand, foot, cam, solenoid, or pressure . . . the Hannifin "Crown" Line of filters, regulators, and lubricators for lasting air power efficiency . . . all are built by Hannifin to just one standard, the best.

Turn to Hannifin, too, for expert help in applying air power components. A Hannifin field engineer is as close to you as your telephone, wherever you are. Write us for his address—or, he's listed in the alphabetical section of Thomas Register. It's that easy.

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IT'S A FACT... IN 1910 A 100 WATT BULB
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ATTEMPTED TO SUPPLY TODAY'S
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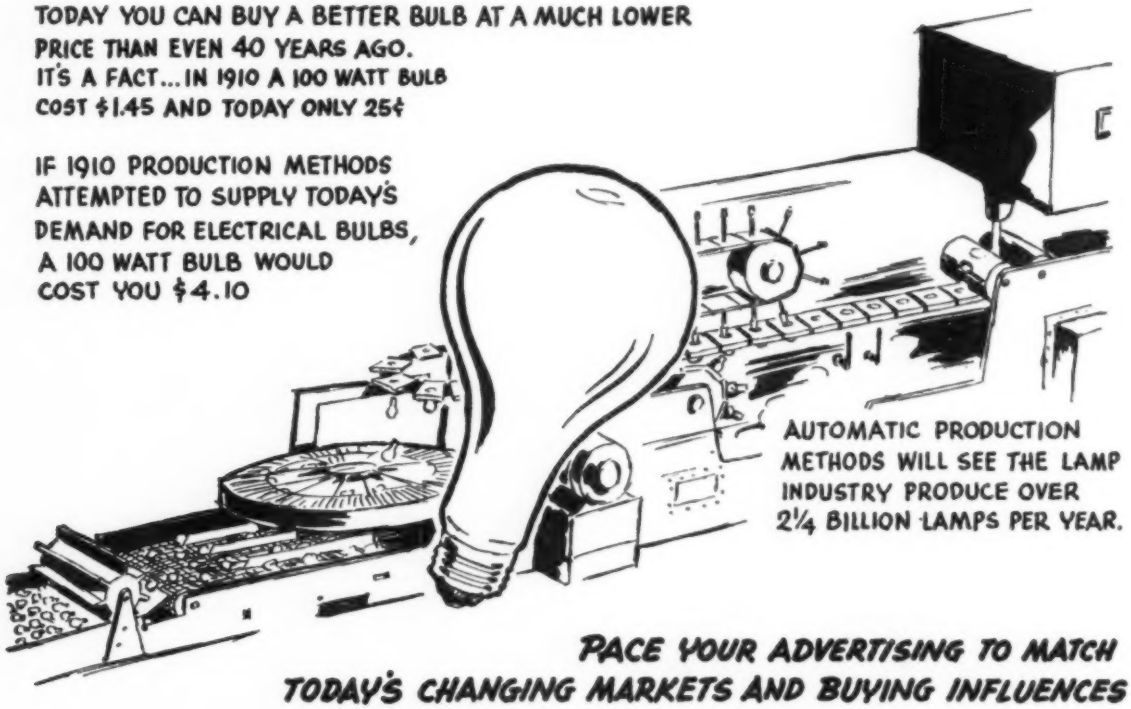
A 100 WATT BULB WOULD
COST YOU $4.10



AUTOMATIC PRODUCTION
METHODS WILL SEE THE LAMP
INDUSTRY PRODUCE OVER
2¼ BILLION LAMPS PER YEAR.

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TODAY'S CHANGING MARKETS AND BUYING INFLUENCES

REACH AUTOMATION-MINDED MEN IN ALL
MANUFACTURING INDUSTRIES THROUGH AUTOMATION

Penton Building, Cleveland 13, Ohio

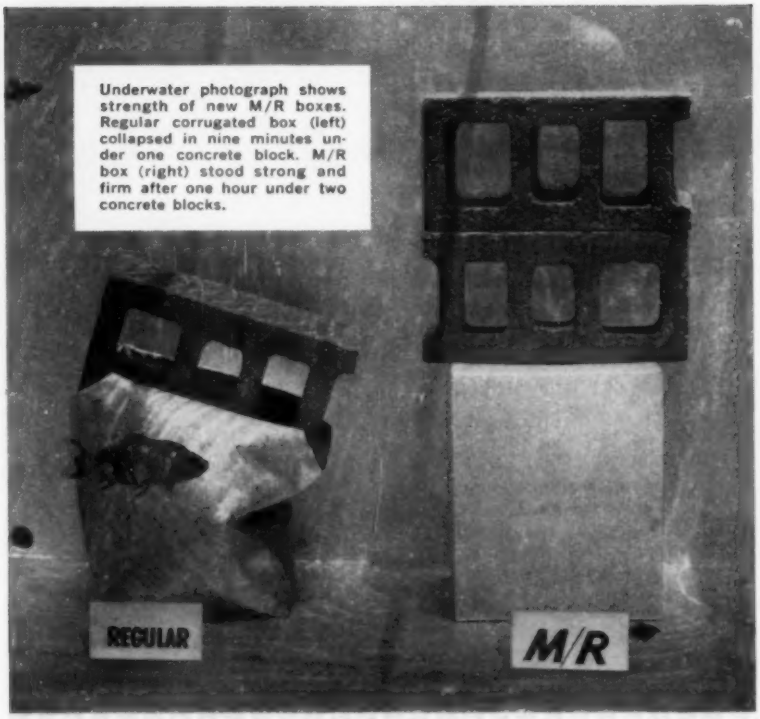
trol panel and can be installed in combined housing with the recorder. The controller receives a signal proportional to the measurement and compares it with another signal representing the desired control point. The deviation thus produced is combined with a feedback signal and the resulting amplified output actuates an electropneumatic or electrohydraulic valve operator.

DATA SAMPLING switch manufactured by Genisco Inc. provides up to 3000 contacts per second for data processing systems. High contact pressure is achieved with minimum friction and wear by a revolving nonmetallic wheel successively depressing metal reeds against a common contact ring. Up to 200 contacts per revolution can be provided with either make-before-break or break-before-make operation. No "wipe" is required, and there is no motion between the reed and contact ring during the conduction period.

King-Size Handling System

CONVEYORIZED flowcoat painting system, capable of handling steel bar joists 24 inches wide by 65 feet long, is being designed and built for a major steel producer by the Industrial Div., R. C. Mahon Co. According to Mahon engineers, the conveyor system will include provisions to up-end the 65-foot joists, and automatically transport them through drip and drying sections.

SCIENTIFIC instruments have revolutionized the food processing industry's methods. Control mechanisms maintain the critical conditions necessary for uniform and safe



Underwater photograph shows strength of new M/R boxes. Regular corrugated box (left) collapsed in nine minutes under one concrete block. M/R box (right) stood strong and firm after one hour under two concrete blocks.

New M/R Corrugated Boxes

stay strong when wet...even under water!

Important news about Hinde & Dauch's new M/R (moisture resistant) corrugated boxes: Hydrocooler tests show M/R boxes shed water; stay strong and durable for packing and shipping all kinds of wet products. Moreover, M/R boxes stack high and straight. They save packing and handling time, provide remarkable product protection. Initial tests indicate shipping damage to peaches reduced 50%. And the smooth, clean surfaces of new M/R boxes can be colorfully printed with your brand message. H & D Package Engineers are ready to design an M/R corrugated box for your product. Write, wire or phone for complete information today!

HINDE & DAUCH
Division of West Virginia Pulp and Paper Company
AUTHORITY ON PACKAGING • SANDUSKY, OHIO
15 FACTORIES • 42 SALES OFFICES

HINDE & DAUCH Division of West Virginia Pulp and Paper Company
5808 Decatur Street, Sandusky, Ohio

Please rush me samples and detailed literature on new M/R corrugated board.

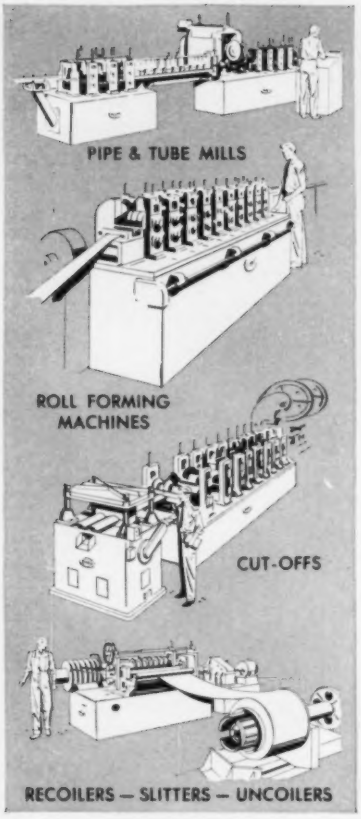
Name_____

Company_____

Address_____

City_____ Zone____ State_____

Circle 662 on Page 155



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Special attachments and auxiliary units can perform additional operations such as welding, coiling, punching or embossing without extra labor cost while increasing production speed.

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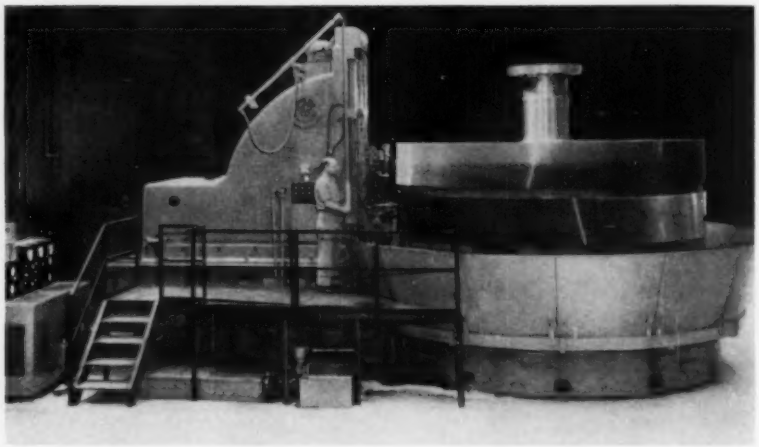
(ferrous or non-ferrous)

Circle 663 on Page 155



VERTICAL GEAR SHAVER developed by Michigan Tool Co. is used at a General Electric Co. plant to shave marine turbine-reduction drive gear tooth surfaces. The large machine can provide a finish as fine as 12 microinches on either internal or external spur, helical, or herringbone gears varying from 80 to 200 inches in diameter and with face widths up to 74 inches. For fast shaving, the machine is equipped with dual cutting heads which are independently adjustable for correct angle. During cutting the heads are slowly reciprocated up and down across the face width of the gear as the work table rotates the gear at speeds varying from 0.93 to 15.16 rpm.

processing of foodstuffs. Recorders furnish charts and records of these conditions. These instruments control machines which smoke meats, pasteurize milk and beer, refine vegetable oil, temper chocolate, and sterilize cans.

SPOTLIGHTING PEOPLE

William G. Alexander appointed assistant general manager of Stromberg-Carlson—San Diego . . . **William F. Oswalt** named general manager of the Direct Current Motor and Generator Dept., General Electric Co. . . . **William H. Leedy** joined Roto Mfg. Co. and Lima Electric Products Co. as vice president in charge of sales . . . **Arthur J. Raymo** appointed factory manager of the Eddystone Div., Baldwin - Lima - Hamilton Corp. . . . **Charles L. Long** named head of the Project Engineering Dept., Chainveyor Corp. . . . **Albert M. Dexter** named director of metrology at Pratt & Whitney Co. Inc. . . . **Andrew Syska** joined C. I. Hayes Inc. as a research engineer . . . **Max D. Liston** appointed director of engineering, **Thomas V. Parke** named director of product standards, and **Earl C. Janson** appointed director of manufacturing at Beckman Instruments Inc. . . . **Paul N. Stanton** named manager of the Machine Tool Div., Clearing Machine Corp. . . . **E. S. Mathiesen** appointed works manager, **G. W. Bolln** named manager of operations planning, and **C. J. Steinke** named manager of operations production for Cutler-Hammer Inc. . . . **C. Ronald Bach** named applications engineer for Norwood Controls Div., Detroit Controls Corp. . . . **Glen R. Simmons** appointed director of research and development at Western Electric Engineering Research Center . . . **Philip D. Goodman** named manager of market research at Clevite Transistor Products, Div., Clevite Corp. . . . **Henry J. Dumas Jr.** joined B-I-F Industries Inc. as a development engineer specializing in automatic control devices . . . **Edward L. Braun** joined Genesys Corp. as director of systems and electronics . . . **Ralph L. Jaeschke** named chief engineer of the Dynamatic Div., Eaton Mfg. Co. . . . **Harold S. Burt** joined Conveyor Systems Inc. as chief engineer . . . **Roy Hock** appointed chief engineer of Technitrol Engineering Co.

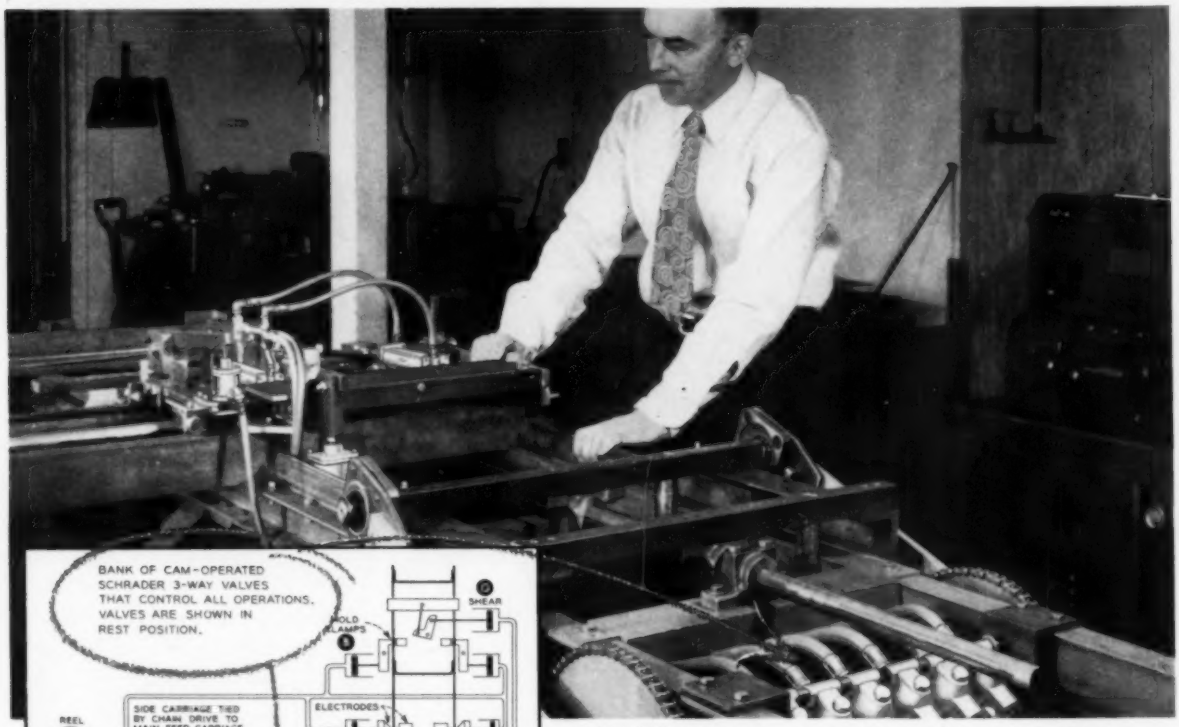
SPOTLIGHTING PRODUCTS

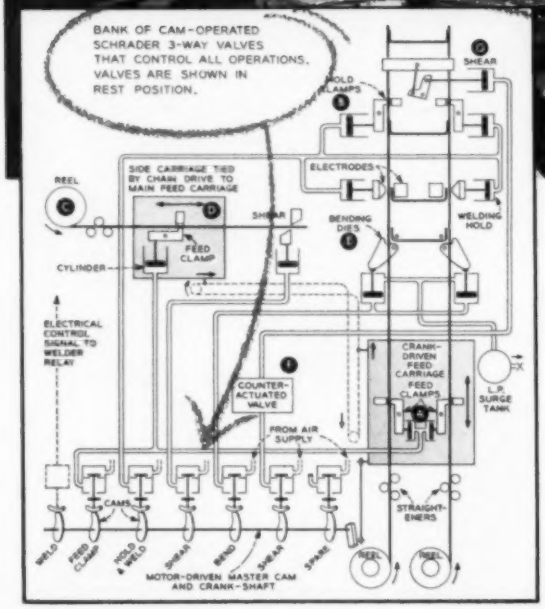
Electric heating elements embedded in silicone rubber for greater application flexibility are available from Watlow Electric Mfg. Co. The units can be used to provide temperatures up to 400F and are waterproof, very thin, and available

YOU, TOO, CAN AUTOMATE IT YOURSELF ...WITH SCHRADER AIR PRODUCTS

Very often you can automate manufacturing operations simply by applying Schrader air controls to existing plant facilities.

Here's a man with ideas who automated a complex job—increased production, reduced unit costs, safely and easily—without making a large capital investment. He did it with a planned Schrader air control system. Chances are excellent that you can do the same thing—with Schrader air products. Air can do an almost limitless range of work: automatic drilling, reaming, clamping and holding, shearing, forming, staking, grouping and interlocking assembly operations for quicker parts handling and assembly.





PROBLEM: Feed heavy wires into machine, shear off pieces, shape them, weld pieces together and eject as finished wire webbing. Fast. Economically. Automatically.

SOLUTION: Air Controls selected from Schrader's complete line. Neat bank of valves—actuated by cams on master cam shaft—operate synchronized system. Clamps A feed wires to holding Clamps B as carriage moves back and forth. Counter-actuated valve F operates cut-off shear G after desired number of cycles. Wire C, fed from carriage D, is sheared, formed by dies E, welded to the other two wires.

RESULT: One man performs *double* the output of three men at a fraction of the cost of a new machine.

Design it yourself! Schrader Air Control components—the most reliable self-contained power units—can help you adapt quickly to your manufacturing needs.

Schrader®
a division of SCOVILL

QUALITY AIR CONTROL PRODUCTS

A. SCHRADER'S SON • *Division of Scovill Mfg. Co., Inc.*
472 Vanderbilt Ave., Brooklyn 38, N. Y.

How do I start? How did others get started? Send me informative literature and information about Schrader's Automate-It-Yourself Air Products.

Name_____ Title_____

Company_____

Address_____

Circle 664 on Page 155

BASIC WEIGHT CLASSIFIER

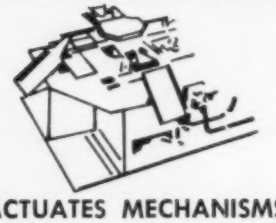
...new aid for controlling your quality and costs

CHECKWEIGHS
products
packages and
assemblies

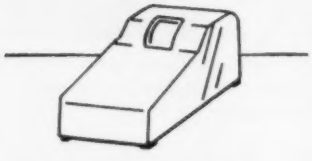
CLASSIFIES
by weight

. . . and through electronic controls, performs these and many other remote functions!

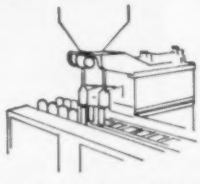
OPERATES SIGNALS



ACTUATES MECHANISMS



RECORDS DATA



CONTROLS PROCESSING

Now you can checkweigh or classify items by weight and utilize the data wherever you need it — and in the form that best fits your needs. The Basic Weight Classifier, employing Shadograph Scale with photocell controls, provides electronic signals which indicate correct weight, or over or under within pre-set limits. Any number of classifications from 2 to 128 may be used. Units are available to handle items in any shape in a capacity range from 2,000 milligrams to 100 lbs. Write for Bulletins 3333 and 3347.

Exact Weight SCALES

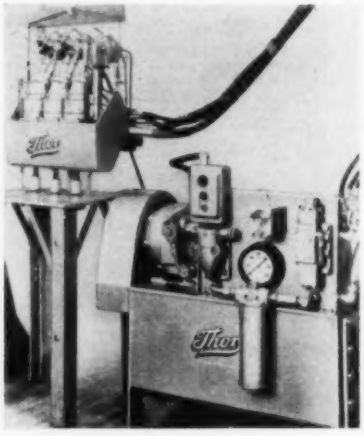
THE EXACT WEIGHT SCALE CO.
907 W. FIFTH AVE., COLUMBUS 8, OHIO
In Canada P.O. Box 179, Station S, Toronto 18, Ont.

Sales and Service Coast to Coast

Find us in your local 'Yellow Pages'

BETTER QUALITY CONTROL . . . BETTER COST CONTROL

in any plane shape. . . . *Flexible steel sandpaper* manufactured by Red Devil Tools is now available in a 9-inch width designed especially for industrial users. Comparable to medium grade sandpaper, the steel product is made by punching 0.036-inch diameter holes, 150 per square inch, in 0.004-inch thick steel sheets. Produced in 1600-feet rolls, the flexible sandpaper will give long life when used on hard or soft woods, plaster, plastics, or soft metals. . . . *Transistorized preset counter* for automatic, continuous measurement of insulated wire has been developed by Dynapar Corp. Designed for the control of automatic cut-over reel stands, the unit measures wire length in one or ten foot units up to any preset footage. Early warning relay closes at a preset number of feet before final footage is reached, automatically starting rotation of next reel. A mercury relay switch then actuates the cut-over device for transferring the wire to the second reel. A fault counter in the same chassis counts the



HYDRAULIC control system for multiple nutsetting and other multiple power tool operations has been developed by the Thor Power Tool Co. The system delivers uniform torque to ±1 lb-ft simultaneously to as many as 20 threaded fasteners. Torque is uniformly delivered to each threaded fastener by means of a two-stage hydraulic driving arrangement. In the first stage, the hydraulic motors are synchronized for relatively high speed to give fast rundown of threaded fasteners. In the second stage, they hydraulically shift into torque synchronization at a lower speed, simultaneously delivering identical torque through each spindle, regardless of the type of opposition or resistance, until all spindle movement ceases. At that instant, pressure is relieved completely and all fasteners have been tightened to the identical torque.

Circle 665 on Page 155

Circle 666 on Page 155→

GAYLORD POINTS OUT
MANY WAYS YOU CAN SAVE IN PACKAGING

Gaylord uses a sharp pencil to survey your *total* packaging operation—checks those hidden costs that are frequently more important than the price of the box.

If you demand increased production, improved protection and important savings in corrugated packaging . . . call in your G-man. He'll help you erase any packaging errors, leave an indelible mark on the credit side of the ledger.

GAYLORD
CONTAINER CORPORATION

Gaylord Boxes

HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

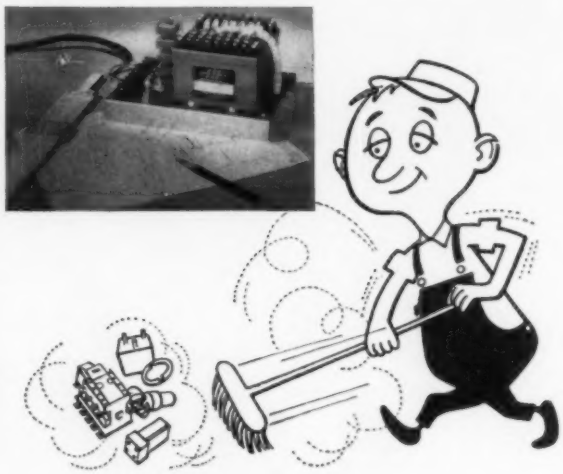
DIVISION OF **Crown Zellerbach Corporation**

JOURNAL OF APPLIED CONTROL DEVICES THAT NEVER WEAR OUT

For Control Engineers Who Are Wearing Out Before Their Time

HIGH SPEED STATIC SWITCHING *(at half the price)!*

Sylvania Electric Products Co. engineers have just replaced an electronic relay, two small mechanical relays, a limit switch, and a separate power supply with a single CONTROL switching reactor which costs only half as much! They did it by taking advantage of the multiple windings on a CONTROL switching reactor—equipment which, because of its static operation, never wears out. Seems a high speed assembly operation on one of Sylvania's complex, highly automated vacuum tube production machines calls for a magnetic clutch to drive an index table. The clutch orients the work part by rotating it until current flows through two properly located contacts. Our CONTROL switching reactors not only cut costs in half, but do a job that the relays couldn't do: provide the ultra high speed signal necessary for proper switching in the automated assembly. *It worked so well Sylvania said, "I'll be switched!" We said, "With a 10,000 to one switching ratio, and ratings of 15, 75, 150 and 300 VA, most anything for control can be!"*

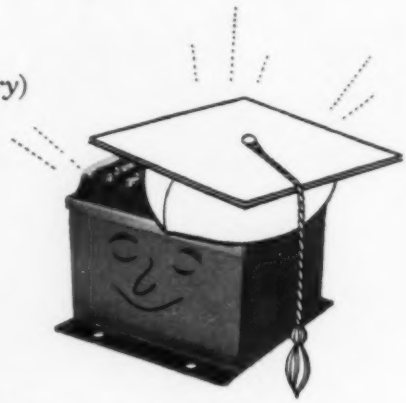


ONCE UPON A TIME . . . *(time delay, that is)*

Versatile, we are too! The same type of CONTROL switching reactors that work so well for this high speed switching also are used by Sylvania engineers to eliminate production breakdowns caused by relay failures in time delay circuits. Many pneumatic time delay relays on their production machines were dying young (three months of age or less). CONTROL switching reactors (which, naturally, never wear out) not only have no moving parts, but do a dandy job with time delay relaying, easily handling 6,000 closures per hour. Sylvania happily expects its CONTROL reactors to last twenty years. *"Right now," Sylvania says, "we're not too worried about what will happen after that." Need you be any more worried than they?*

LOGIC, MY DEAR WATSON *(. . . is elementary)*

Our educated switching reactors are masters at logic—the kind that gets built into automatic control operations. AND, OR, NOT, MEMORY and TIME DELAY—all are built into these high IQ reactors. By employing several isolated control windings, one reactor can translate many inputs (from push buttons, limit switches or other reactors, for instance) to any logic needed to switch very appreciable loads. And are they easy to use! Order standard units right from the catalog. You need no high falutin' systems engineering or auxiliary hardware (single purpose logic units, preamplifiers or transformers). *No wonder logical people order our logic-providing switching reactors. Can we send complete details to you?*



Reliability begins with CONTROL

A DIVISION OF MAGNETICS, INC.

Dept. A-54, BUTLER, PENNSYLVANIA

number of faults in a reel, and automatically accumulates the number of good and faulty reels. . . . *Automatic solder dispensing devices* which meter paste solder on parts on a production line are available from Fusion Engineering. Paste solders developed by the company for use in the devices contain a stable blend of solder alloy, flux, cleaning, and tinning agents. After a uniform quantity of solder is metered on the part, production line can pass through heating zone to complete automatic operation. Labor savings up to 95 per cent are possible with production rate increases of 500 per cent.

SPOTLIGHTING PLANTS

Rese Engineering Corp. has formed a Digital Systems Engineering Dept. to facilitate expansion of the company's operation as designers and manufacturers of magnetics test equipment and data processing systems. . . . **Minneapolis-Honeywell Regulator Co.** has purchased the Marion Electrical Instrument Co., manufacturers of precision electrical measuring and indicating panel meters. . . . **Hunt Valve Co.** is the new name of C. B. Hunt & Son Inc., manufacturers of air and hydraulic control valves. . . . **Bendix Aviation Corp.** has announced a new plant expansion in Detroit, Mich., to provide additional floor space for the manufacture of numerical control systems for machine tools. . . . **Narda Microwave Corp.** has formed a new subsidiary, Narda Hydraulics Corp., to design, manufacture, and market hydraulic components, pre-oilers and preservation machines, and specialized test equipment for the aircraft, automotive, oil, and machine tool industries. . . . **Connecticut Instrument Corp.** has been recently formed to develop and manufacture research and control instruments. . . . **Trans-Weigh Co.**, manufacturers of belt conveyor weighing and control systems, has moved into a new plant in King of Prussia, Pa. . . . **Industrial Instruments Inc.** has recently purchased Mosher Electronic Controls. . . . **Lindberg Industrial Corp.** has acquired Continental Industrial Engineers of Chicago which will be known as the Continental Div. . . . **Ex-Ceil-O**

ASSEMBLED IN SECONDS with a
BENERSON AUTOMATOR

No worry about clumsy hands—production slow-downs or unstable quality. Precision assembly by a Benerson AUTOMATOR is automatic! The AUTOMATOR is a pre-engineered indexing unit which provides the motivation to the automation assembly operation. Benerson Automation specialists then adapt this base unit to your specific requirements—specially engineered for the feeding, orienting, placing and ejecting assemblies.

If you assemble volume parts—today's competitive market demands a Benerson AUTOMATOR to reduce assembly costs in your plant!

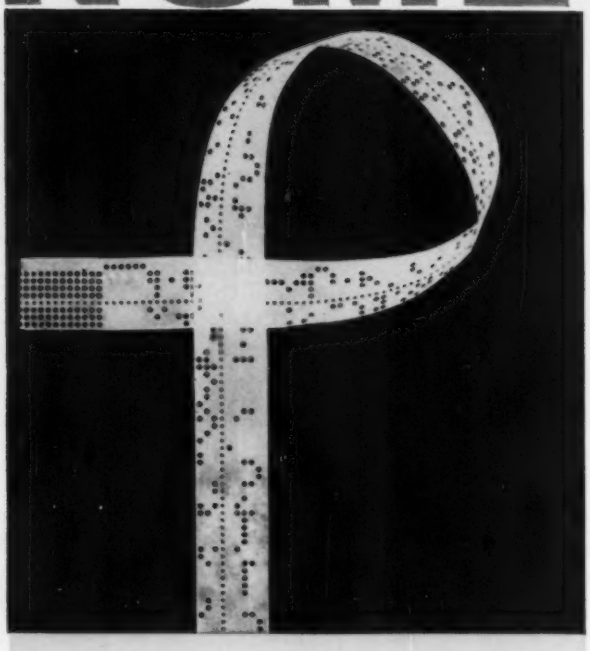
FURTHER INFORMATION AND DETAILS ON REQUEST. WRITE:

BENERSON CORPORATION
STATION A, BOX 127, EVANSVILLE, INDIANA

Benerson Engineers Are Automation Minded

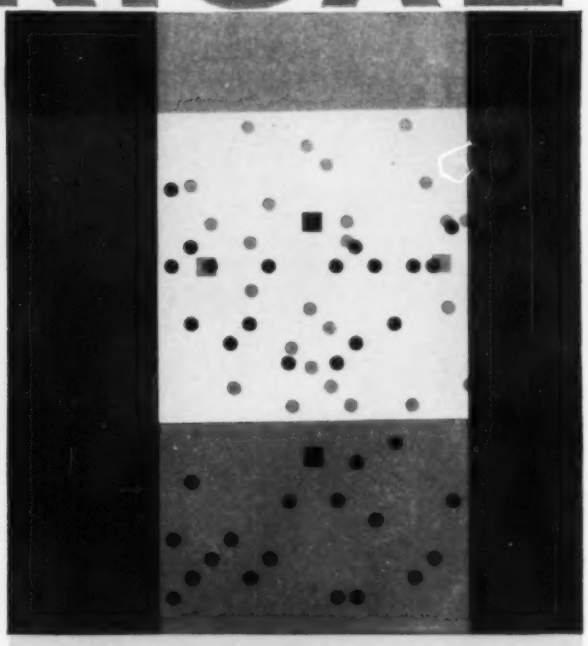
Circle 668 on Page 155

NUMERICAL



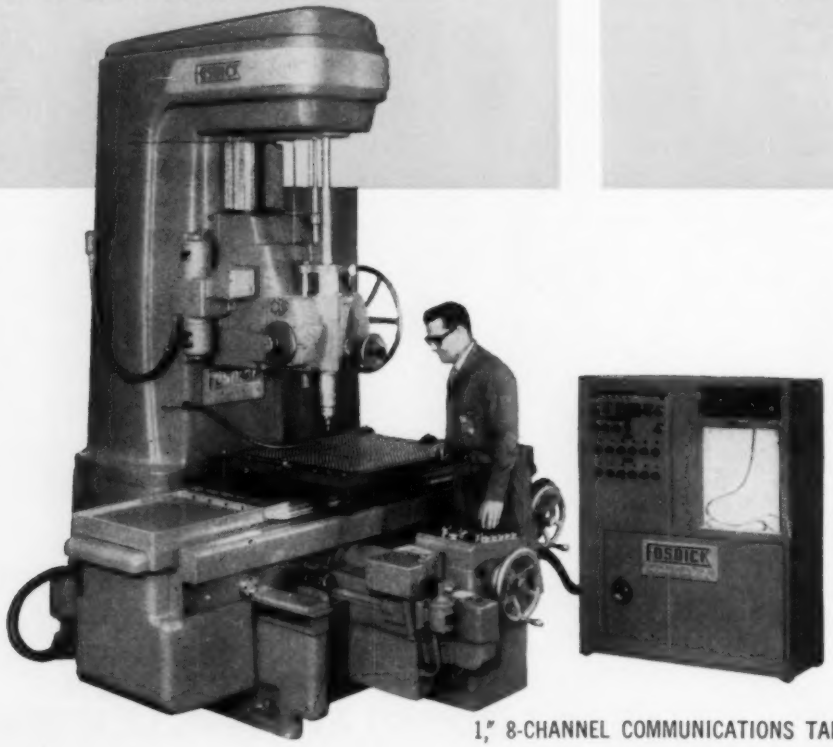
1″ 8-CHANNEL COMMUNICATIONS TAPE

Inexpensive, widely used throughout industry, these tapes may be prepared simply on a Flexowriter or similar equipment, usually by the Production Engineering Dept. Provides a typewritten record automatically for easy checking against pre-planned program.



4″ MYLAR PLASTIC TAPE

Least expensive of the generally accepted tape systems, particularly suitable for smaller shops machining parts with relatively few holes. Tape can be prepared easily by shop personnel.

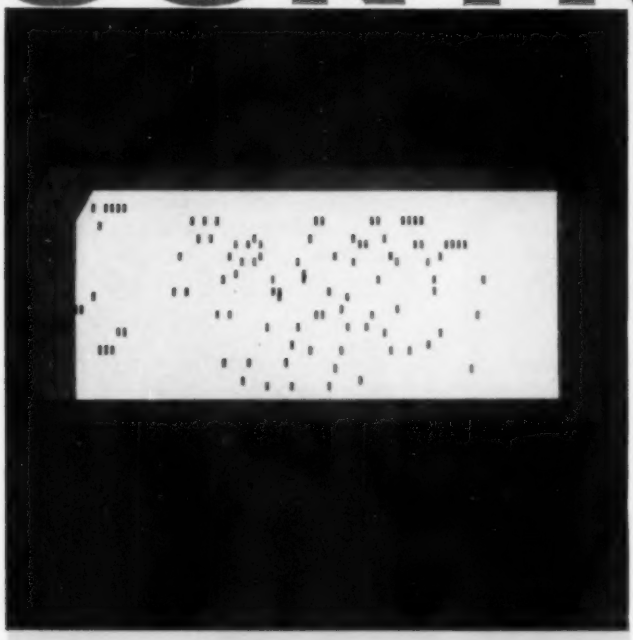


1″ 8-CHANNEL COMMUNICATIONS TAPE

4″ MYLAR PLASTIC TAPE

CONTROL

for Fosmatic JIG BORERS and JIG GRINDERS



PUNCHED CARDS

This system can be integrated with card systems already in use by your company. Each job is programmed in a "deck" of cards; provides great flexibility, since an operation can be added or eliminated simply by making a new card or removing an old one.

Any tape or card reader can be used to control a Fosmatic Jig Borer or Jig Grinder. And because the functions of the standard Fosmatic are actuated electrically, numerical control can be installed in the field—economically!

Speeds and feeds are changed by controlling electro-magnetic clutches through relay contacts. Table and saddle position is determined by a measuring system actuated by direct reading dials. For numerical control, these dials are driven by a fractional hp motor.

On a Fosmatic, you can program as many functions as you wish. Table X and Y positions (to .0001"), Feeds and Speeds, Spindle start and stop, Spindle feed start and stop, Spindle feed depth, Spindle head height, Automatic tool change. And only Fosmatic gives you a visual numerical check of coordinate location plus operation sequence number.

Example of savings made with Fosmatic numerical control. The illustration (left) shows one half of a mold with 900 cavities, each of which requires nine operations—a total of 8100! Time for the entire job was 100.25 hours, 25% of time consumed previously on a conventional jig borer.

Write or call today for complete information on a numerically controlled jig borer or jig grinder to improve your production method.

PUNCHED CARDS

Buy a Fosmatic today—add Numerical Control tomorrow

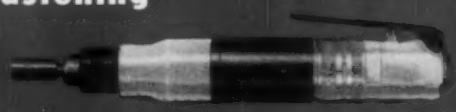
Circle 669 on Page 155

tools, not tranquilizers!!!

for drilling

BUCKEYE-QUIETOOL DRILLS

for fastening



BUCKEYE-QUIETOOL SCREWDRIVERS NUTRUNNERS

for sanding

BUCKEYE-QUIETOOL SANDERS

Air tools are built for working, not for sleeping. Even the amazingly muffled Buckeye QUIETOOL drills, sanders, screwdrivers and nutrunners won't lull you to sleep! But they do their work with precise efficiency, and make less exhaust noise in the process than you ever believed possible of an air tool.

How come? Because in designing these new tools, we included the muffler as an integral part, designed into the tool from the start. There are many more reasons why these new Buckeye tools operate so quietly, stuff about decibels, sones, microbars, etc. . . . but you'll be more interested in the results than in how we came by them.

A letter or postcard, with your name, your company name and address, and the single word QUIETOOL, will bring complete information and, if you like, an obligation-free trial-test right in your own plant.

Why AIR Tools?

Because air is everywhere, just waiting to be put to work . . . because continuous operation can't possibly harm an air tool . . . and because, if you're using Buckeye air tools, you can almost forget about tool maintenance.

For a special air tool for a difficult job, or a standard air tool for routine work, your best buy is Buckeye. Write for our new catalog.

Buckeye Tools CORPORATION

5009 SPRINGBORO PIKE • DAYTON, OHIO

Circle 670 on Page 155

Corp. has acquired all outstanding capital shares of a machine tool firm in Germany which will operate as an independent subsidiary for the manufacture of lathes, medium size planers, and textile looms. . . . **Consolidated Electrodynamics Corp.** and **Elliott-Automation Ltd.**, London, England, have concluded an exclusive licensing agreement under which the British firm will manufacture and market CEC designed analytical and control instruments.

FLAT MULTICONDUCTOR cable manufactured by Organic Development Corp. is designed to control interwire capacitance. By grounding the wire on each side of any particular lead, the signal loss can be kept to a minimum, and the need for a shielded or coaxial cable can be avoided. The flat cable is available in many sizes, spacings, and colors and can be manufactured to coincide with the spacing in printed circuit board plugs.

MEETINGS AND EVENTS

Nov. 3-7—

The American University. Fifth Institute on Electronics in Management to be held at the American University, Washington, D. C. Additional information is available from Lowell H. Hattery, American University, 1901 F St. N.W., Washington 6, D. C.

Nov. 5-9—

National Tool & Die Manufacturers Association. Annual convention to be held at the Sheraton Hotel, Philadelphia. Further information is available from George S. Eaton, NTDMA headquarters, 907 Public Square Bldg., Cleveland 13, Ohio.

Nov. 10-13—

National Electrical Manufacturers Association. Annual meeting to

be held at the Traymore Hotel, Atlantic City. Additional information is available from Joseph F. Miller, NEMA headquarters, 155 E. 44th St., New York 17, N. Y.

Nov. 17-21—

Society of the Plastics Industry Inc. Eighth National Plastics Exposition and Conference to be held at the International Amphitheatre, Chicago. Further information is available from William T. Cruse, SPI headquarters, 250 Park Ave., New York 17, N. Y.

Nov. 19-20—

Northeast Electronics Research and Engineering Meetings. Sponsored jointly by the Boston, Connecticut, and Western Massachusetts sections of the Institute of Radio Engineers, meeting to be held at Mechanics Hall, Boston. Additional information is available from R. R. Leonard, Minneapolis-Honeywell Regulator Co., Newton Highlands, Mass.

Nov. 20-21—

National Foundry Association. Annual Meeting to be held at the Drake Hotel, Chicago. Additional information is available from Charles T. Sheehan, NFA headquarters, 53 W. Jackson Blvd., Chicago 4, Ill.

Nov. 30-Dec. 5—

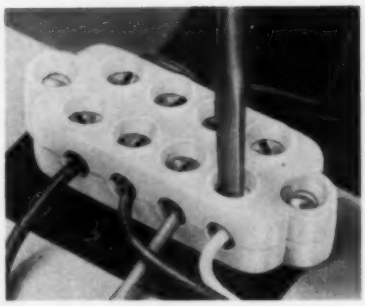
American Society of Mechanical Engineers. Annual Meeting to be held at Hotels Statler and Sheraton-McAlpin, New York. For further information contact ASME headquarters, 29 W. 39th St., New York 18, N. Y.

Dec. 1-5—

American Society of Mechanical Engineers. National Exposition of Power and Mechanical Engineering to be held at the Coliseum, New York. Additonal information is available from E. K. Stevens, International Exposition Co., 480 Lexington Ave., New York 17, N. Y.

Dec. 2-4—

Electronic Industries Association. Third EIA Conference on Reliable Electrical Connections to be held in Dallas, Tex. Additional information is available from W. O. Richards, 224 Cedar St., Syracuse 3, N. Y.



QUARTER-TURN with a screw driver is all that is necessary to connect electrical wires to a terminal block developed by Camblock Corp. Each terminal in the block contains a reverse rotary V-cam. After the wire is inserted, the cam is turned and wedges the wire ends tightly against the inner walls of a rectangular bus. Terminal block is available with up to 20 stations and will handle wire sizes up to 18 gage.

Dec. 3-5—

Eastern Joint Computer Conference. Technical program and exhibit to be held at Bellevue-Stratford Hotel, Philadelphia. Additional information is available from Norman N. Alperin, Radio Corp. of America, Moorestown, N. J.

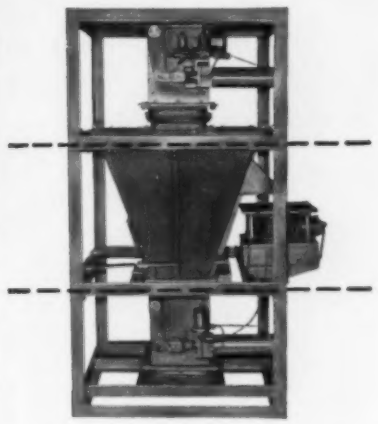
Dec. 8-10—

American Nuclear Society. Winter Meeting to be held at Hotel Sheraton-Cadillac, Detroit. Additional information is available from ANS headquarters, P. O. Box 963, Oak Ridge, Tenn.

Dec. 28-31—

American Marketing Association. Winter Meeting and Exhibit to be held at the Morrison Hotel, Chicago. Further information may be obtained from AMA headquarters, 27 E. Monroe St., Chicago, Ill.

THE W-C HOPPER SCALE



standardized components adapt it to a full range of material handling methods, control instrumentation

Take a good look at this hopper scale. It has many practical features for almost any weighing application.

Take the upper and lower frames. They are designed to accommodate many standardized feed and discharge components: sliding gates, vibratory feeders, screw feeders and others. These units are pre-engineered; their performance has been fully proven in use. Costs are, therefore, correspondingly lower. Satisfactory operation is confirmed in advance.

Now look at the middle or hopper frame. Note the flexure mountings. They give stability to the unit and deliver a single component of force to the weight transmitter regardless of load distribution. The transmitter, itself, may be either electric or pneumatic; the signal can be used for weight indication, recording, automatic batching.

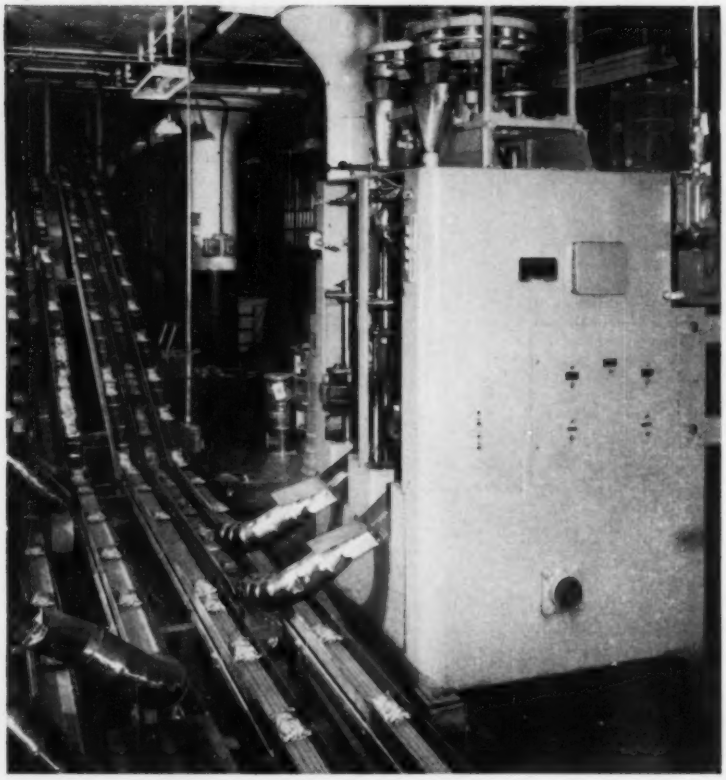
Write for Catalog 12.
Clear text, lots of pictures.

W-C

S.A. 1659

WEIGHING and Control COMPONENTS, Inc.
206-C Lincoln Ave., Hatboro, Pa.

Circle 671 on Page 155



Why General Mills chose Robo-Wrap for Pick-A-Pack

This new Robo-Wrap at General Mills' Chicago plant will soon be joined by 2 more machines—because it has been proved that Robo-Wrap increases the efficiency and economy of their packaging operation.

The Robo-Wrap forms, fills and seals pillow packages. Under production line conditions at General Mills, the Robo-Wrap cruises at 100 bags a minute and can run at 120 . . . it provides a better seal and fewer rejects even at these high speeds because its unique hand-over-hand action holds jaws in sealing position for a longer time . . . it minimized work stoppages due to torn paper roll stock because the combination mechanical and hydraulic jaws exert a strong, jerk-free pull . . . it is easily adaptable to handle a variety of other products.

Robo-Wrap packages in cellophane, paper, poly, plastic or laminates. See how it can answer your needs for speed, dependability, easy maintenance and adaptability.

Write for Illustrated Robo-Wrap Folder that demonstrates features and advantages important to you.

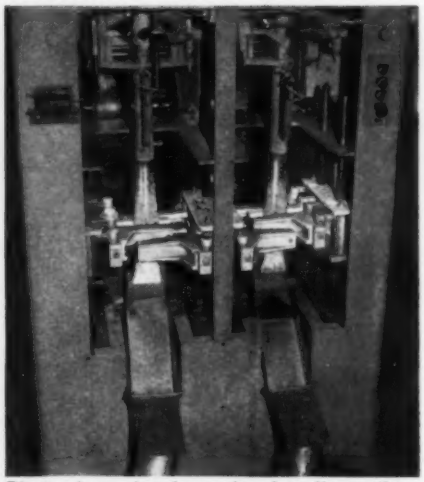
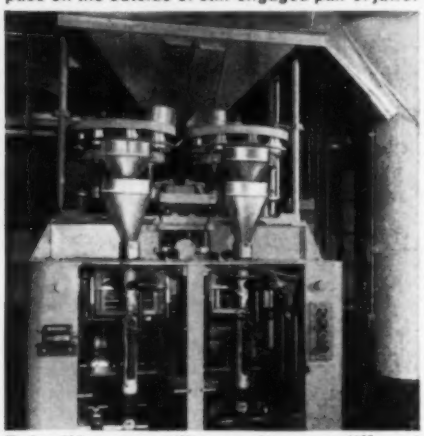


Photo shows hand-over-hand sealing action. Lower jaws, now disengaged, start to go up and pass on the outside of still-engaged pair of jaws.



Robo-Wrap versatility permits many different feeding arrangements. At General Mills, there is a volumetric feeder leading from storage hopper supplied from floor above.

General Mills Pick-A-Pack Package offers five tasty breakfast foods—Wheaties, Cheerios, Kix, Trix, and Sugar Jets—in one attractive carton.

LYNCH
CORPORATION
Anderson, Indiana

Circle 672 on Page 155

By JAMES C. KEEBLER Managing Editor

This is not Santa Claus and his helper with a frozen sleigh, but William A. McConnell, (left) technical assistant to the executive engineer in charge of vehicles testing, and Andrew A. Kucher, vice president engineering and research, visiting cold weather tests of a '59 model in Ford's "Hurricane Road" test facility.

Test stand at Oldsmobile uses new dynamometer control system developed by General Electric to electrically simulate inertia. System replaces flywheel discs previously used to simulate vehicle mass in lab tests, and enables operator to adjust potentiometer for any desired weight without leaving drivers seat.

Instrumental Automation

AUTOMATION covers a broad range of doing things automatically, just as MUSIC covers a broad range of sounds. In categorizing automation developments some students of the science have dubbed large-lot metalworking operations with the title "Detroit Automation".

Production in this category is not often thought of as being akin to the type of automation discussed at meetings of the Instrument Society of America.

Get an Earful

Todays industrial complex does not readily lend itself to dogmatic categorization. In discussing, "What's an instrument?" at the various booths of the annual ISA show, you could conclude that the only thing all instruments have in common is that they're all delicate. (You'd better not say that above a whisper or you'll surely pick a fight.)

Still it is music to our ears to hear that the basic techniques of getting things done automatically are rather universally valid no matter into what category one wants to catalog himself. Instrumentation-type automation might sound out of place in Detroit but 'tis there just as surely as jazz concerts have been played in Carnegie Hall and Helen Traubel has sung a TV duet with Jerry Lewis.

Highly instrumented production operations include heating cycles of furnaces of all types, balancing operations, testing and calibrating ignition system and dash board components, and engine test stands—to name but a few without checking the files.

Small Lot Problems

Lest the casual reader consider that the technology of automation is restricted to the large-lot operations, let's shout a big WHOA, and have it be known here and now that automaking automaters have job-lot operations too, and they are as interested in doing things automatically here as they are there.

If you are casually cautious that this writer may have slipped a cog, look at a few developments.

What could be "job-lotier" than a research project? Yet the need to do things automatically in this department is so clearly recognized that Lester Ostrander, Jr. of the G. M. Research Staff gave the annual ISA Instrumentation-Automation Conference a paper entitled "Desired Improvements in Instrumentation used in the Automobile Industry."

Ostrander documents two typical instrumentation groups: Proving Grounds, and Research Staff and outlines the needs of each. In the former the rigging is mobile and an underlying philosophy is to have the data recorded at the end of a test. Available power limitations of 12-volt direct current require miniaturization of components and stable inverters to change the dc into 115 volt ac. In the latter the majority of tests do not require mobile rigs and it is generally not required that the data be in final form at the completion of a test run.

Ostrander does not consider availability of transducers a problem. Apparently when a research engineer can't get a needed transducer combination he sits right down and fabricates same.

Data handling is a big problem in making testing operations more automatic. In seemingly no time at all you can automatically have miles of oscillographic records or magnetic tapes that show what went on, but the problem is to present the data in a manner that makes analysis easy.

Road Tested

Truly the function of a proving ground is to see what a car will do under operating conditions. The real test of auto performance may

RUGGED, LOW COST, AIR-POWERED WORK BRING PRACTICAL AUTOMATION

Any plant, big or little, is made up of "small plants" or separate manufacturing centers. Often these separate centers may consist of only a single machine or operation. Sometimes they cover a group of related operations.

For most plants overall automation is usually out of the question, but every plant can "SPOT-AUTOMATE" these separate manufacturing centers with Bellows "Controlled-Air-Power" Work Units.

These unique power devices turn hand operated or controlled machines into automatic production units; they operate and control hoppers, conveyors, ejector devices, valves, etc.; they provide the power source for fast, safe, inexpensive assembly devices; they are the principal components in an unlimited number of shop-built, special purpose machines.

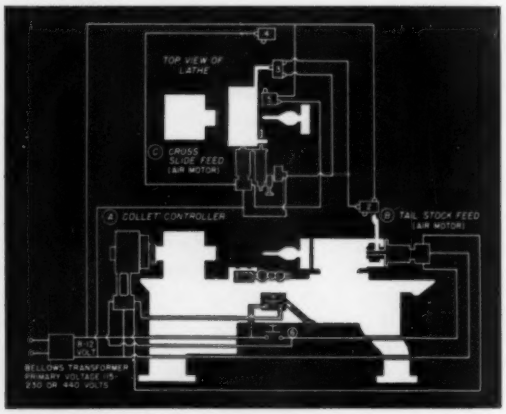
Each work unit is designed for a specific function: rotary or linear work feeders, work clamping and holding devices, rack and gear power feeds, light and heavy duty drill units, hydraulically controlled air cylinders. Each is a complete package in itself with all controls built-in, but all are designed for easy interlock with each other.

Bellows air-powered work units and Bellows "SPOT-A-MATION IDEAS" will give you an entirely new conception of the cost saving possibilities of air power.

SPOT-A-MATION IDEA L-1

CONVERTING A LATHE WITH BELLOWS "CONTROLLED-AIR-POWER" DEVICES

Typical Application of Bellows "Controlled-Air-Power" Devices on a standard lathe to (1) Automatically Close Collet, (2) Feed Tail Stock equipped with Drilling Tool and (3) operate cross slide to feed two form tools.


TOP VIEW OF LATHE
CROSS SLIDE FEED (AIR MOTOR)
COLLET CONTROLLER
TAIL STOCK FEED (AIR MOTOR)
BELLOWS TRANSFORMER PRIMARY VOLTAGE 115-230 OR 440 VOLTS

SEQUENCE OF OPERATION

Operator loads work piece into standard Lathe Collet and depresses start switch (1) which energizes Electroaire Valve of Collet Controller (A), clamping work piece. Start Switch (1) simultaneously energizes Advance Solenoid of Air Motor (B) bringing Tail Stock and Drilling Tool into work piece completing one operation.

As Tail Stock reaches fully advanced position, trip dog of Air Motor (B) actuates switch (2) breaking hold circuit to "Stop Valve Control" of Cross Slide Feed (C) through switch (3) releasing Cross Slide to advance one form tool.

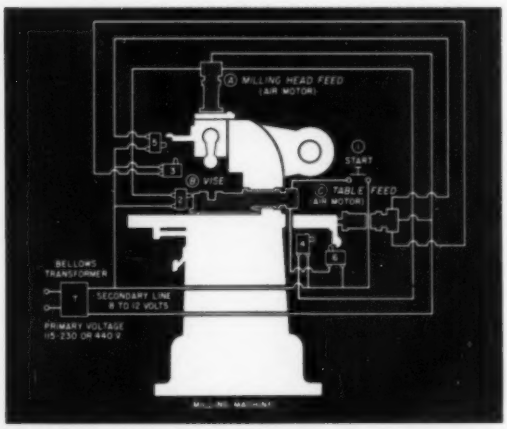
Air Motor (C) is held at mid-point of Cross Slide travel by the "Stop Valve Control" on the Bellows Hydro-Check. This stop action is accomplished elec-

The Bellows Co.
AKRON 9, OHIO

SPOT-A-MATION IDEA MM-1

SEMI-AUTOMATIC OPERATION OF MILLING MACHINE

Typical Milling Machine Application of Bellows "Controlled-Air-Power" Devices to (1) Clamp Work Piece, (2) Feed Milling Head, and (3) Feed Milling Machine Table through the cutting cycle.



SEQUENCE OF OPERATION

Operator loads work piece into jaws of Bellows CVEH-50 Electrically Controlled Air Vise, which have been machined to contour of work piece, and depresses button of Start Switch (1) clamping the piece in position.

The Vise Jaws close and trip normally open Switch (2) energizing the "Advance" Solenoid of Air Motor (A) which lowers the milling head and cutter into work position. When the milling head reaches fully advanced position Switch (3) is actuated, energizing advance solenoid of Air Motor (C) placing the milling table in motion.

Air Motor (C) advances, feeding the table through the cutting cycle, until Switch (4) is actuated. At this

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UNITS WITH BUILT-IN CONTROLS TO PLANTS BOTH LARGE AND SMALL

With built-in electrical operating controls*, built-in four-way directional valve, built-in two-way piston rod speed controls—and requiring only a single air connection—this unique air cylinder is the power source for Bellows integrated work units.

These "Spot-A-Mation Ideas" Can Point The Way To Important Cost Savings In Your Plant

Bellows "SPOT-A-MATION IDEAS" give you easy-to-follow drawings, wiring diagrams, operational sequence and list of equipment required to convert drill presses, milling machines, lathes, arbor presses, etc., to automatic units; show how to automate wood working equipment; how to simplify conveyor operation; how to build inexpensive assembly devices; show unique special purpose shop-built multiple drilling machines and other special metal, woodworking and plastic fabricating equipment.

They are free, on request. Write Dept. AU 1158, *The Bellows Co., Akron 9, Ohio for this new SPOT-A-MATION IDEA FILE. If you have a specific operation you would like to SPOT-AUTOMATE, our Bellows Field Engineer Staff will be happy to work with you.*

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*Controls may be 8-12 volt, explosion-proof, or 115 volt to JIC Standards. Option pneumatically or manually operated controls also available.

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DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION

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Circle 673 on Page 155

be to actually try it out everywhere in the world, but from a practical engineering standpoint this is the long hard way. The trend in proving grounds is to be able to duplicate operating conditions anywhere in the world and be able to repeat those conditions on a programmed basis so that variables of auto or component design can be evaluated against fixed parameters.

To accomplish this the test track is reduced in size and instrumented to produce automatic control of test cycles. Instead of taking the car on the road you let the road go by under the car.

Ford's new "Hurricane Road" is 20 feet wide by 12.5 feet high by 30 feet long and can make a simulated "Fairbanks to Phoenix" run in less than 30 minutes. Here a test car can be subjected to winds up to 140 mph, temperatures from zero to 160F, relative humidity from zero to 95 per cent, rain from 0.5 to four inches per hour, and sun load from zero to 480 Btu per hour per square foot.

The dynamometer wheels are synchronized with the fan system to produce an air speed exactly matching the road speed of the vehicle. The arrangement provides automatic simulation of inertia and windage loads for transient and acceleration tests.

Control system has an operator's console with analog displays and set-point controllers for all independent variables, and digital displays for all dependent variables. Data handling facilities provide for automatic electric typewriter logging of any variables selected in any desired sequence. Routine calculations are performed automatically.

Tape Recorded

The automakers are not alone in automating auto test operations. Esso Research and Engineering Co. has replaced its daily "milk run," which covered a 3½-hour, 101-mile route in metropolitan New Jersey traffic. Now rather than send them on the road the test cars needed to evaluate experimental motor fuels and lubricants are operated without drivers on an automated treadmill.

The treadmill accommodates up to eight unmanned cars, all of which can be "driven" simultaneously by one man stationed in a control house. Magnetic tape recordings, made during on-the-road runs, control the acceleration and braking cycle of the test cars in an exact duplication of the way a motorist would start, accelerate, slow down and stop his car during normal driving.

The vehicles' rear wheels ride on and rotate wide steel drums belted to "inertia discs" that absorb the power an automobile would normally use to accelerate its weight along a conventional road. They are adjustable and can be set to correspond with the road weight of any car—including a driver. The fans take up the power a car would ordinarily expend in overcoming wind resistance on the open road. (The fans also serve a practical purpose in cooling the engines of test cars.)

Hydraulically-controlled clamps attached to the cars' rear axles hold the vehicles in a fixed position on the treadmill. This rig provides more accurate test information than is obtainable from conventional road runs because different fuels and lubricants can now be compared under unvarying conditions, thanks to the magnetic control tapes. (The tapes can be used over and over again to reproduce exactly the same patterns; but even the best driver would be unable to duplicate precisely how he handled the car over a road run.)

In doing away with the need for routine road runs, the installation has freed experienced test car drivers for more specialized road testing programs.

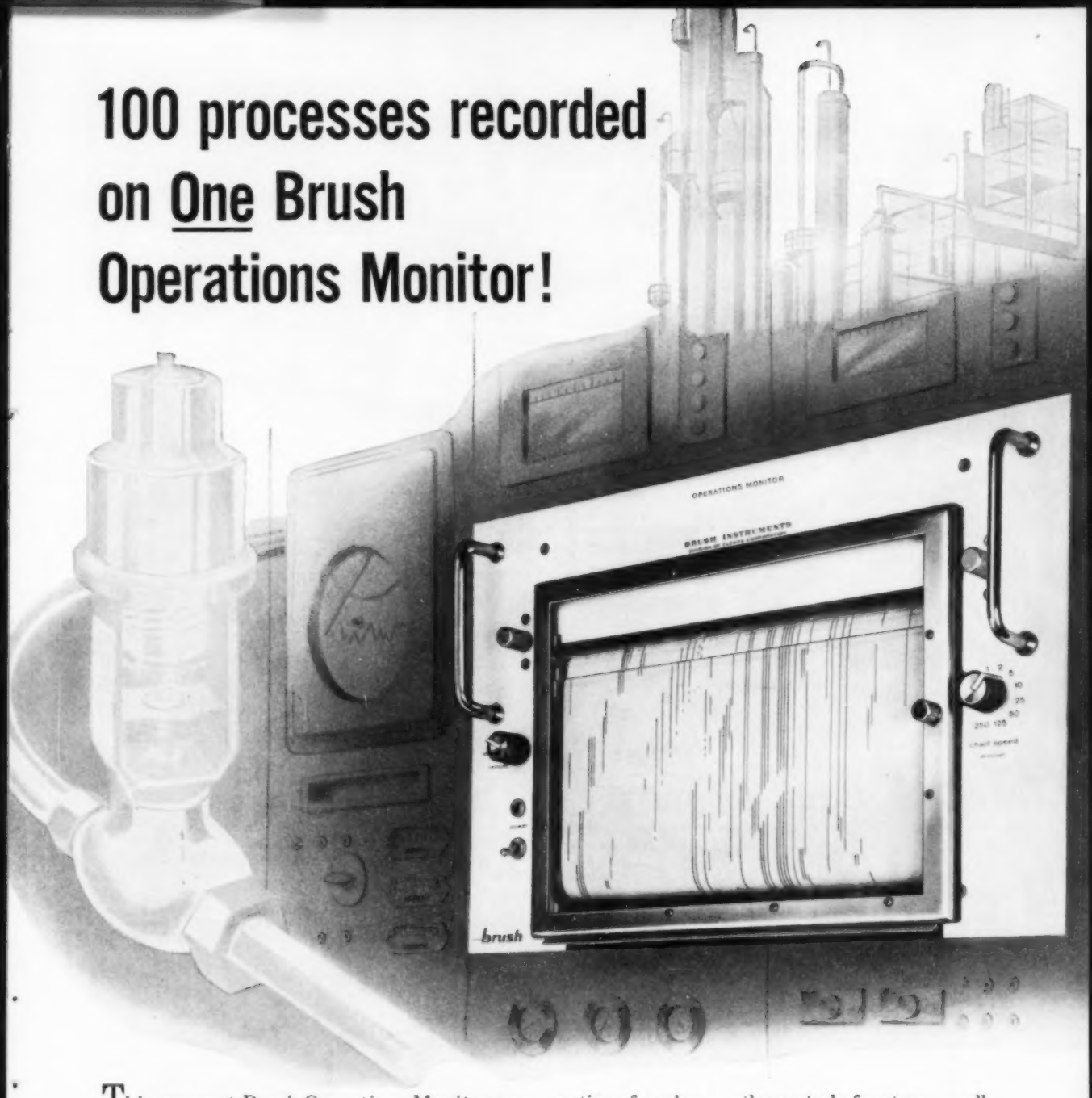
Oliver G. Lewis, research associate at Esso Research and Engineering Co., one of three co-inventors of this automated treadmill for test cars watches one man "drive" eight cars. Magnetic tape recordings made during on-the-road tests control acceleration and braking cycles to test experimental fuels and lubricants.

Genuine Imitation Inertia

Developments in test equipment take place as fast as developments in the products being tested. GE's Industry Control Dept. has come up with a control system that enables Oldsmobile to run faster, more accurate performance tests. Previously their inertia discs were a stack of flywheels. Weight of the rotating mass could be altered only in 200-pound increments. Setup involved adding or removing a disc from the stack. The new dynamometer control uses electrically simulated inertia with stepless adjustment by potentiometer. This allows simulation of any degree of grade for climbing tests and reduces test setup time.

Automatic testing operations in labs often end up as automatic testing operations on production lines. Automation developments in this area have the potential of offering better cars in many ways.

100 processes recorded on One Brush Operations Monitor!



This compact Brush Operations Monitor can improve the control of power distribution systems, chemical processes and automated production lines.

On a moving chart only 12″ wide, 100 separate operations can be recorded at the same time . . . what happens or doesn't happen . . . monitoring present recording and indicating devices. For example, the opening or closing of a valve . . . the action of a relay . . . the control of motors . . . all are documented in a time relationship to other operations. You get an immediate picture of an *entire situation* at any time. Sixteen different time bases can be selected from remote or on-the-spot locations.

Write to Brush for details. Engineering assistance is available at all Brush factory branches, strategically located throughout the United States.

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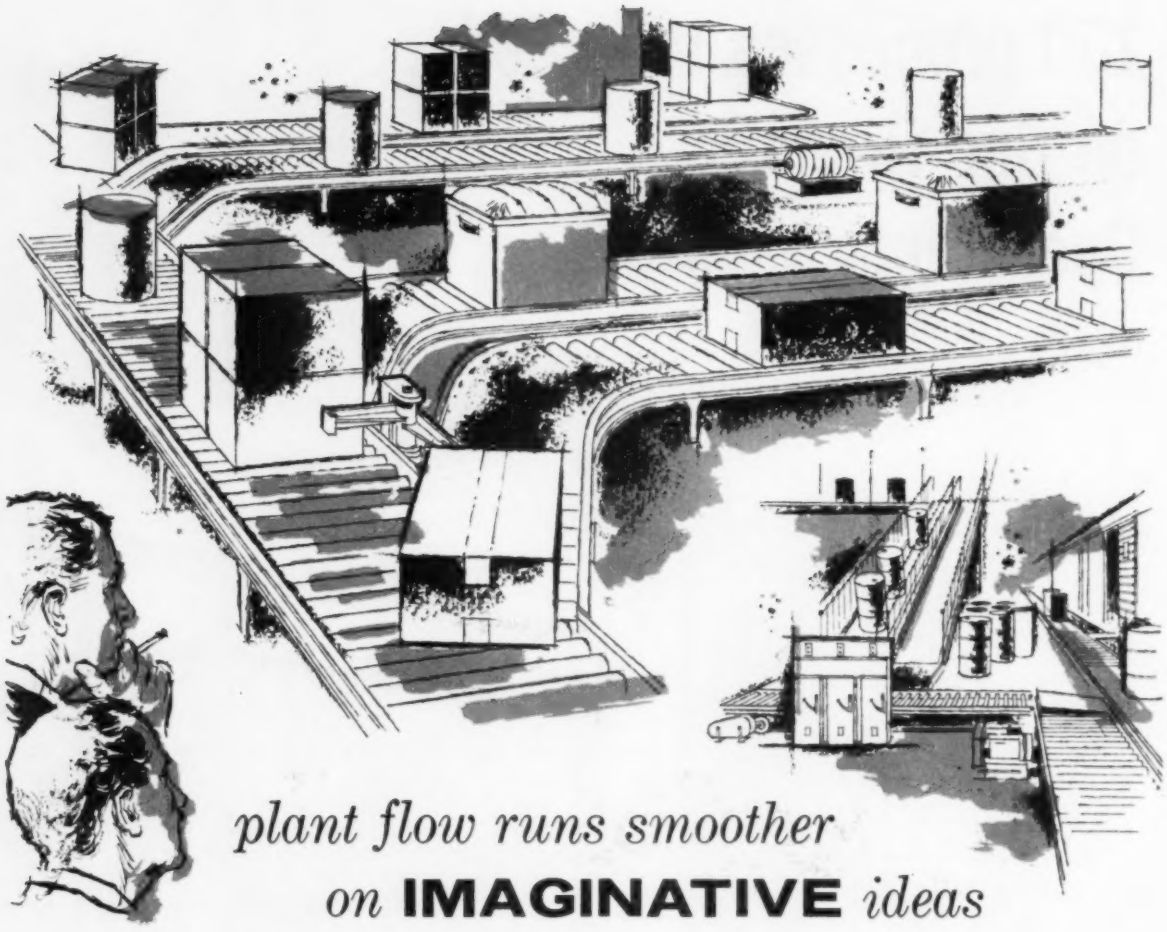
Circle 674 on Page 155



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Imaginative new ideas in modern materials handling can smooth out your plant's work flow. For factories, mills and warehouses across the country, conveyor systems engineered by Alvey speed up output and cut production costs as much as 30 per cent. This unique Alvey approach often pays for itself in just a few months. Unless you have reviewed your package handling methods lately, you may be missing similar savings.

Whether you need a completely integrated, automatic system or individual package handling units, Alvey can put this creative planning to work for *you*.

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S.K.F. Industries, Inc.	J. P. Stevens & Co., Inc.
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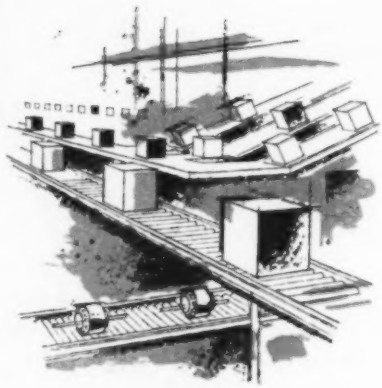

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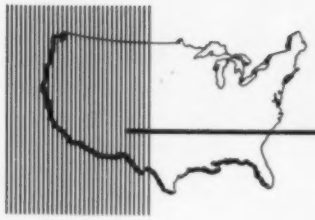
Circle 675 on Page 155



western trends

By PATT PATTERSON
Los Angeles, Calif.

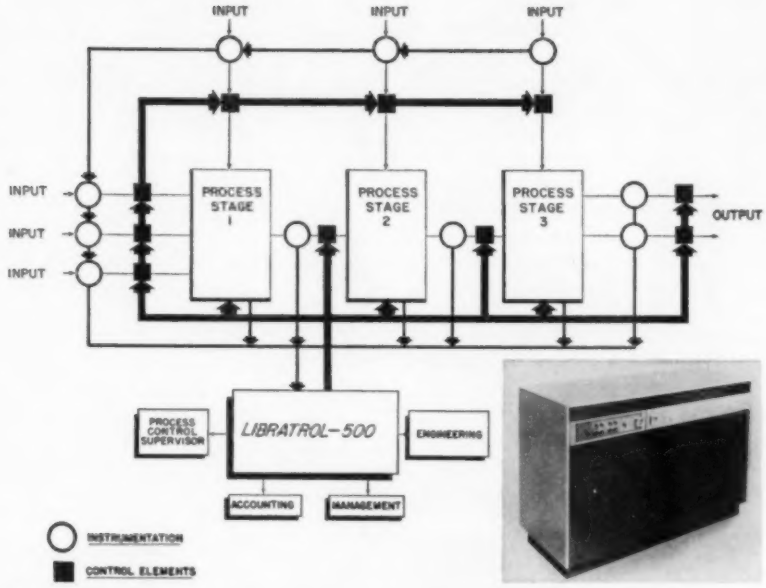


Diagram indicates role of computer in automating chemical processing system. The Libratrol—500, developed by Librascope, Inc., and marketed by GPE Controls, Inc., can collect data to guide operator in making decisions; collect and analyze data to provide operator with correct settings; or provide a closed loop for complete automatic control of the process.

Computers and Controls

WESTERN metalworking manufacturers do not generally fit into the volume production pattern of items. The trend here is more toward shorter run, highly customized units, often in the miniature or precision category. As a result, the nonmetalworking industries have seen the greatest rise in automatic processes on a plant-wide basis. Lumber in the Pacific Northwest; food processing in California; papermaking, petroleum, and utilities throughout the entire West—all have seen a consistent growth of automation.

One of the primary factors determining the trend of automation in the West is the dependence of a large proportion of Western manufacturers upon the aircraft and missile industry. Even the rapidly growing electronic equipment industry places the largest part of its output with the airframe and missile manufacturers.

In aircraft and missiles, the basic concept of frozen design and high volume production is unfeasible. Engineering changes, particularly in the light of our armament race with Russia, are a vital necessity not only to the aircraft and missile makers, but also to the electronic armament and controls industries. In one case, during a 3-year production schedule for a missile, as many as 18,540 engineering changes were incorporated into the design. Freezing the design of our weapons would merely promote obsolescence, as unwanted in armament as it is desirable in consumer products.

Ordinary mass production methods, to which automation is particularly suitable, are not practical or economical in such industries. The appearance of automation, therefore, has generally been limited to individual pieces of equipment with a great dependence upon tape or other versatile programming control.

An additional complication of custom manufacture is the desirability of using one machine to perform several operations on an intermixed number of different pieces.

Process Control

Because of the requirement for this specialized type of automatic equipment control, not only in metalworking, but in the process industries, the West has become a leader in producing control systems and computers. From the development of miniature computers and logic circuits to guide a missile have come bigger units that apply the same principles of precise control to processes and even entire plants. A recent development in this field is the multipurpose process control system, built around a rapid-response digital computer.

The Libratrol—500 has been designed for all three of the presently used computer control techniques: monitoring, computer-directed, and full automatic control. The system is built by Librascope, Inc., and marketed by GPE Controls, Inc., subsidiaries of General Precision Equipment Corp. In its most basic use, the Libratrol — 500 monitors the processing operation, compiles the various data from transducers and thermocouples, performs the required computations and presents the information to the process operator. Specific information for management and accounting is also tabulated.

The system may also be used for the more sophisticated computer-directed control. Here the system is used to calculate, on the basis of data monitored by the instrumentation and information stored in the

How to "Turn on a Dime"

Today, production men must "turn on a dime" to meet changing output requirements. One day sales are off—machines are idle; the next equipment must produce at top speed to meet a rush order. This requires unusual flexibility in both men and machinery.

To help solve this problem, General Electric offers a new, packaged, adjustable-speed drive—the Speed Variator. Offering wide speed ranges and good regulation, it can help your machines produce a greater variety of goods, faster and at lower cost per unit.

Find out how this versatile new drive can help you keep pace with today's fast changing production demands. Write for GEA-6643. *Direct Current Motor and Generator Department, Erie, Pennsylvania.*

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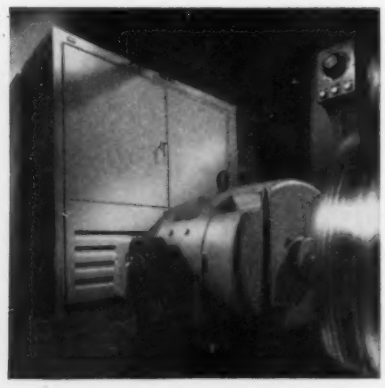

computer, what the optimum set-points in the process should be to realize maximum efficiency, maximum output, or to reach a desired condition in minimum time. This information is presented to the operator to permit him to alter the process controls.

In processes where the relationship between primary and secondary effects of control variations are understood, the computer system is used for full automatic control of the process. With the control loop closed through the computer, automatic trimming operations are carried out by monitoring set-points and changing them as required.

One of the big advantages of this type of system is that management may install the equipment at early and less sophisticated stages of process plant development, and utilize the results to install more fully automatic control as the process requirements are evaluated. In many cases, such a system could be utilized to monitor pilot and short runs to establish basic operating criteria.

Automatic Palletizing

The food processing industries are major contributors to the Western economy. Because of the cyclic harvest seasons of various food crops, a problem of warehousing final output arises. An entire pack of a single food product may be made during the course of two or three months, and then stored until shipments throughout the remainder of the year gradually deplete the stockpile.

Warehousing, then, has become a target for automation. Conveyors have long been a standard fixture in leading food packing plants, and automatic pallet routing has been increasingly used in larger warehouses.

One of the big hurdles, however, has been the necessity to manually load pallets. When the first case palletizer was developed, packers found handling costs reduced by $10,000 to $18,000 per year, and they urged the automatic equipment manufacturers to produce palletizers that would automatically load bales, bags, and drums.

One of the newest automatic warehouse installations in the California & Hawaiian Sugar Refining Corp. in Crockett, Calif., incorporates automatic palletizers for bales, multiwall paper bags, and cases (at the time of this writing, a leading equipment manufacturer was working on a palletizer for drums).

The C & H warehouse includes not only the palletizers, but power-driven roller conveyors which move the loaded pallets through an operator-controlled dispatch station. From there the loads move automatically to storage or shipping areas. The automatic stacking, which is the heart of the unit, has greatly reduced damage to bags, bales, and cases. With bags, for example, hand stacking often produces rips and tears and boosts rehandling and container costs.

Bag stacking was the toughest problem for the equipment manufacturer (Lamson Corp.) to overcome. Conveyors bring the 50 and 100-pound multiwall paper bags from the second, third, and fourth floor packing areas. As they arrive at the second floor palletizing area, the bags pass a sorting station where an operator programs the destination on a control panel. The bags then automatically continue to six accumulator lines.

The automatic palletizers stack the bags, at approximately 30 per minute, and place them upon the pallets. The pallets are then discharged into a common conveyor line. The entire palletizing operation consists of three automatic stackers for paper bales, two for cases, and three for the paper bags. One of the loaders can handle 60 by 44-inch pallets and loads up to 4500 pounds.

Western Notes

True-Trace Corp., El Monte, Calif., maker of hydraulic tracer controls, has developed a fully automatic control system for machine tools which employs a magnetic tape.

The Buzza-Cardozo Co., Los Angeles greeting card manufacturer, has reduced overall packing production costs by switching to an automatic mechanical wrapping line.

Oregon Saw Chain Corp., Portland, Oreg., has added an automatic multiple-head, conveyor type, abrasive belt grinder to its chain saw line. The grinder performs four grinding and finishing operations in a single pass. The unit features continuous feed and automatic ejection of the blades to the next station.

Circle 676 on Page 155

Circle 677 on Page 155→

5 REASONS WHY YOU SHOULD BUY—

New General Electric Speed Variator

1. Amplistat Regulator offers better speed regulation and adjustable, timed acceleration for improved product quality.

2. Static Exciter, with silicon rectifier, has no moving parts, requires no warm-up, provides more production time, less maintenance.

3. Two-Unit, Four-Bearing M-G Set features Tri-Clad† '55' motor for more dependable performance.

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5. Kinamatic* Drive-Motors provide instant response to control signals. For details on this fast-acting motor see next page.

For more information contact your Apparatus Sales Office or write for GEA-6643. *Direct Current Motor & Generator Department, Erie, Pennsylvania.*

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Additional information is available at your nearest General Electric Apparatus Sales Office. Or, if you prefer, write for Bulletin GEA-6355. *Direct Current Motor and Generator Department, Erie, Pennsylvania.* 813-9

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Selling Solutions

At the recent American Management Association packaging conference in New York, William T. Dooley Jr., Lewis-Howe Co. vice president in charge of manufacturing, highlighted an interesting automation accomplishment: "It has enabled Lewis-Howe to reduce floor space requirements by 20 per cent, substantially reduce the inventory of finished goods, increase the utilization of machinery, and improve its product while reducing visual inspection."

Through careful committee study of costs and manufacturing processes, it was concluded that full company co-operation and foresightedness could create a superior manufacturing system. Their decision was that the ultimate objective had to be a fully automatic, integrated, product-controlled production line including the packaging operation.

Commenting on the development of the equipment necessary, Philip H. Lanham, plant engineer, brought out a factor of top importance in today's manufacturing operations: "We were forced into development work because of our determination to establish a production line that would fit the requirements of our preconceived basic layout. Because previous experience with machine manufacturers indicated that it is difficult to get automatic equipment developed and constructed to meet specific requirements, let alone anticipate future needs, we decided to do our own development work."

Concentration on the merchandising of machines has caused many equipment builders to lose sight of reality. It is high time that builders of productive equipment recognize and view their basic business in its true role—production and process engineering. Machinery needed to implement the manufacturing process plan is secondary. The successful equipment builder's "stock in trade" that provides today's competitive edge is manufacturing process know-how and ingenuity.

Rather than selling machines, the real goal is selling successful solutions to production problems, utilizing the broad techniques of automation to attain long-range cost and quality benefits.

Today's machine builders must become tomorrow's manufacturing engineers.

EDITOR

AUTOMATION

USING DATA REDUCTION

FOR CONTINUOUS PROCESSES

Automatic control of individual process variables is not enough if optimum performance is to be obtained from a production system. Up-to-the-minute information is required by operators and managers so that more efficient and profitable use can be made of production facilities. Data reduction helps toward this goal.

By **W. E. CHOPE,** President, Industrial Nucleonics Corp., Columbus, Ohio

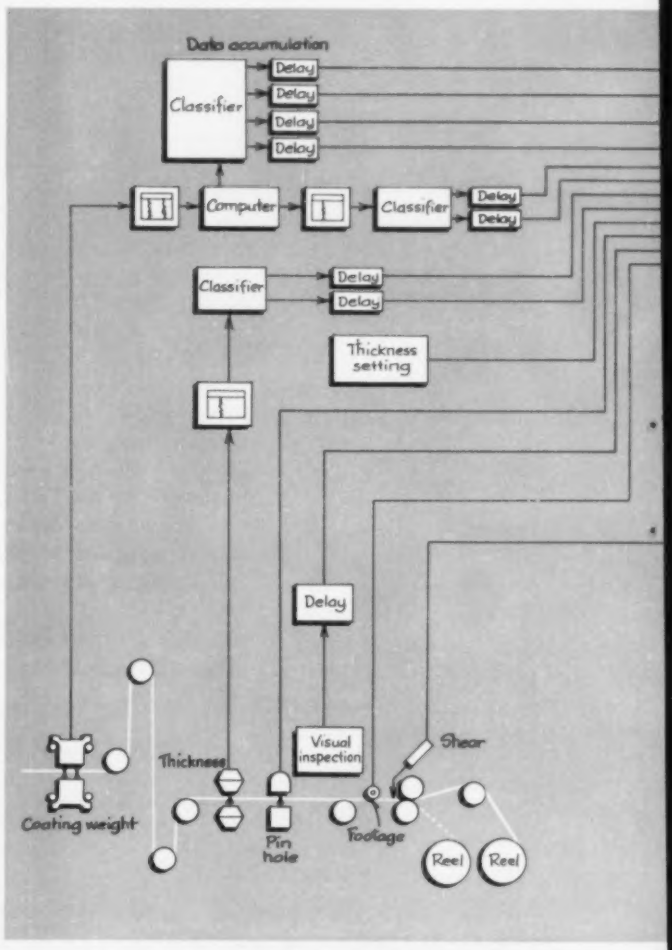
IN INDUSTRY, we are familiar with automatic control of temperature, pressure, and many other variables. The key to automatic control of such variables is information, which, of course, must be obtained by representative measurement. In automatic process control a number of variables related to the process must be automatically controlled and these control functions combined in a compatible system to provide the desired end results. To aid in establishing goals and evaluating results obtained, data reduction can be used to present a selected group of data in prearranged form that is immediately and continuously useful.

In automatic process control, measured information is compared to a target and error signals generated to control an input. The form of this information may be mechanical, pneumatic, or electrical signals. In data reduction, information is converted to digital form for the purpose of analysis. The analysis of such information assists managers to make decisions which may also affect other areas of company activities.

▶ Tin Plate Production

One of the industrial areas in which data reduction has received considerable impetus is in the production of tin plate. Purchasing practice for this product has shifted because can makers feel that the yield of tin cans per ton of steel can be increased about 5 per cent by purchasing tin plate in coil rather than sheet form.

In the manufacture of tin cans only prime tin plate may be used. Prime tin plate is that which is free



of surface and apparent defects, and also has no pinholes. In addition, the sheet must have proper total gage thickness as well as proper thickness of coating on each side of the steel base stock. Because of the nature of the steel rolling process, off-gage strip will occur at both head and tail ends of a coil, and off-gage strip may also occur within the coil because of improper control. In a coil of tin plate, variations in included impurities, pinholes, hardness, coating thickness, surface characteristics, and other factors may occur within the length of a given coil.

If a tin plate producer does not set up nominal specifications on how much prime and how much secondary material can be shipped in each coil, he eventually encounters customer pressure for better quality at the same price because of loose specifications. Then, if he should set up a nominal specification and has no control or continuous data readout on each coil, he will have no knowledge or accounting of how much material has been shipped that is prime and second-prime or secondary. He will thus face the losses, or go without rewards, when producing tin plate of a high prime yield.

It therefore becomes necessary to devise a readout system to provide information which may be used ultimately in the individual pricing of each coil. The same information is necessary in working toward higher quality strip resulting in a higher percentage yield per coil. The transducers which serve as a basis for the data reduction system on the tinning line are currently in existence and are being used to provide information needed for other functions. Thus, the job of assembling a data reduction system is one of determining what end information is necessary and in what form it should be presented.

A layout of a tin plate data system is shown in *Fig.* 1. Transducers for measuring thickness of coating on each side of the strip, total thickness of strip, pinhole detector, footage counter, and a visual inspection keyboard feed information to the data preparation section. At the beginning of each run, the tolerances of each property being checked are inserted in the patch panel by the operator. When starting each coil, the operator inserts identifying data such as coil number, shift, date, and operator code into the identification data section of the system. As the coil proceeds through the operation, data are stored until the completion of the run. At that time, a readout of pertinent data is made in any form such as a typewritten page, punched card, punched tape, or magnetic tape.

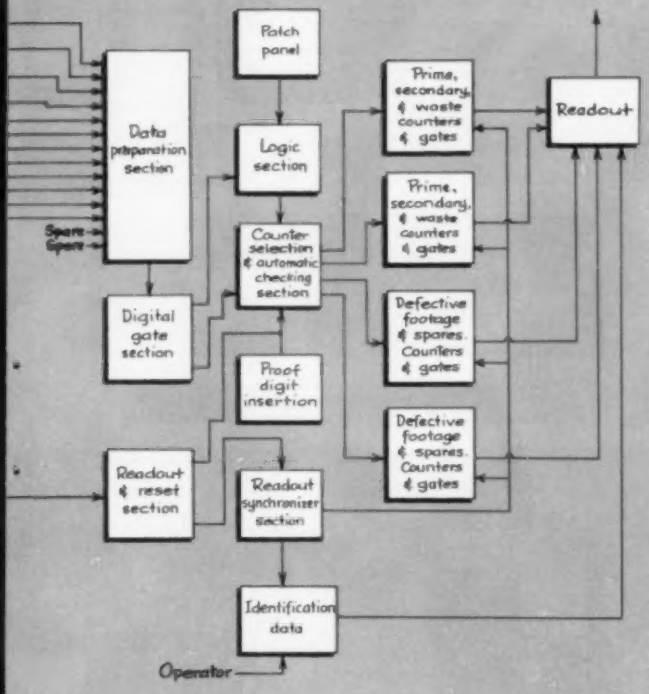


Fig. 1—Transducers in this continuous tin plate line feed information to the data reduction system indicated by the block diagram. Such a data reduction system can give information for the individual pricing of each coil based on the record of variations in characteristics over the length of strip in the coil.

▶ Cold Rolling of Steel

Men of vision in the steel industry also began to apply the concepts of data reduction to the tandem cold reduction mill, *Fig.* 2. Such a mill takes a coil of some given strip thickness and reduces that strip to some desired thickness. The roller must decide where to apply pressure, how much, what the tension shall be, and maintain the whole system in balance. There exists an optimum ratio of pressures and tensions, at each stand and between stands, to obtain any exit gage as a function of the entry gage and properties of the strip.

The heart of the control system in this case consists of gage thickness measurements between stands and at the entry and exit. The measurement of speed is also necessary. This information is fed to a computer controller which is preset to synthesize the characteristics of the rolling mill. The actual setup of mill characteristics is determined in advance and punched on a card. The card is fed to a card reader which sets up the desired mill functions in the controller. As information is fed back from the rolling mill, comparisons are made within the computer to the optimum predetermined balance characteristics. The controller is thus in a position to compare various courses of action to optimum balance characteristics, and feed information back to the mill to execute appropriate control action.

Rolling information is also fed to the mill status board which apprises the roller of what is occurring within the mill. Such information includes for each stand the thickness, percentage reduction, speed, tension, and loading.

For production control uses, information is read

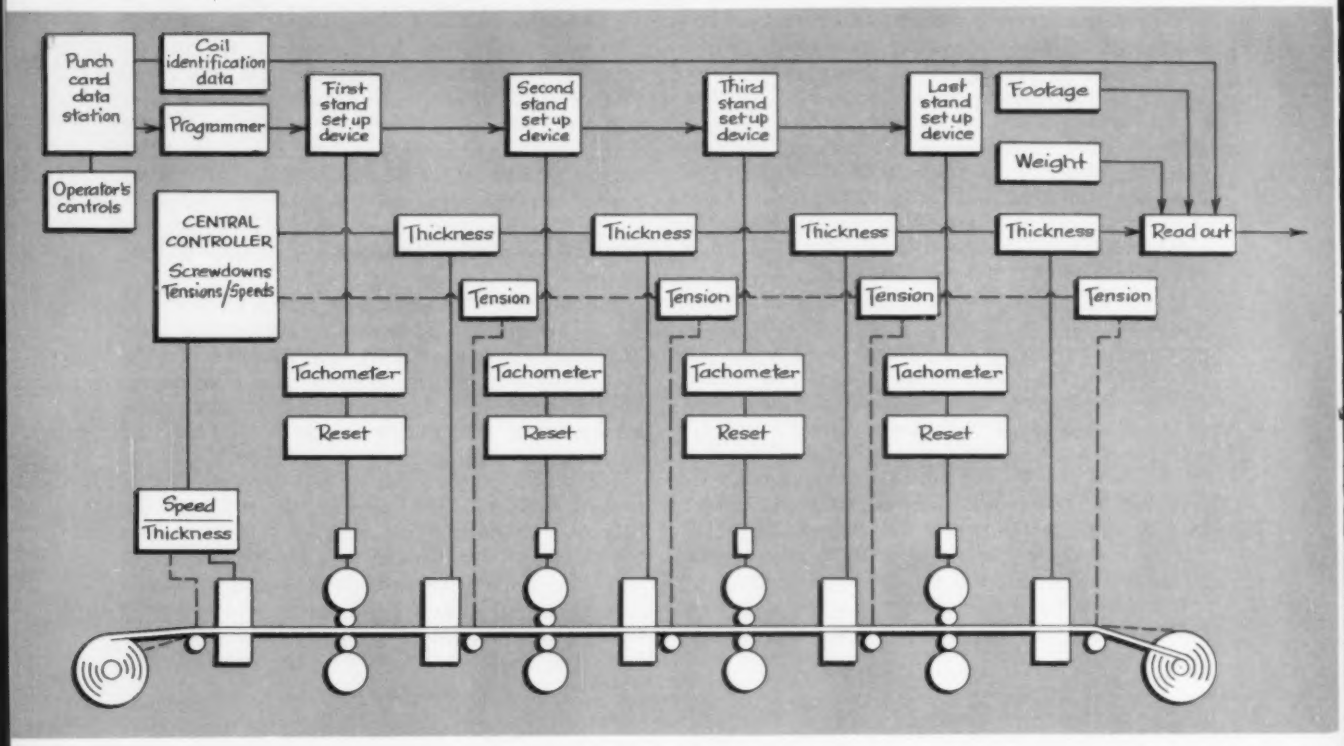


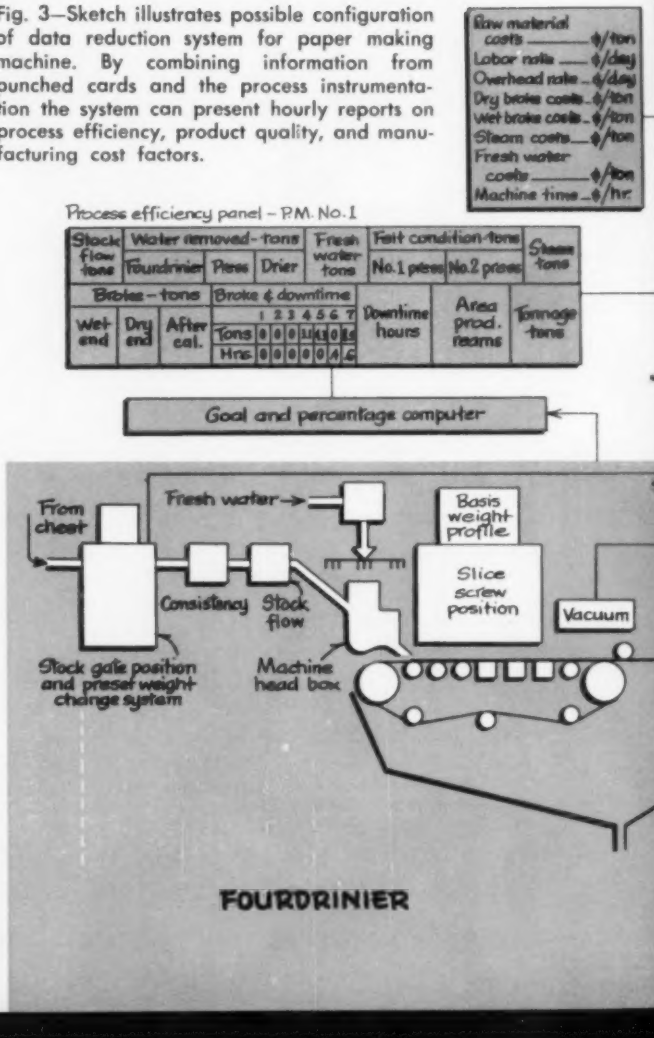
Fig. 2—Diagram shows a tandem cold reduction mill which is automatically controlled and uses a data reduction system. Production control information may be read out on typewritten sheets or punched tapes, and the data made available permit a production accounting of what is happening as it transpires.

out on typewritten sheets and perforated tapes on a shift or turn basis and read out in visual digital form and a printed ticket form for each coil. This information includes calculated speed, actual speed, speed ratio, elapsed time, operating time, time ratio, total footage, prime footage, and the prime yield. This type of information permits a production accounting of what is transpiring at the time it is transpiring. With current information available, action may be taken to rectify production problems as they are occurring, as opposed to learning historically that they have occurred.

▶ Paper Manufacture

Fig. 3 illustrates a suggested over-all machine control and data readout system for a paper machine. We have considered the two major functions of this machine to be that of properly laying out fibers and removing water from the stock introduced to the machine. Starting at the wet end, the system includes a stock gate or valve position indicator, and means to measure consistency and stock flow in terms of pounds per minute as the stock enters the machine head box. Fresh water flow in pounds per minute is also measured.

Fig. 3—Sketch illustrates possible configuration of data reduction system for paper making machine. By combining information from punched cards and the process instrumentation the system can present hourly reports on process efficiency, product quality, and manufacturing cost factors.



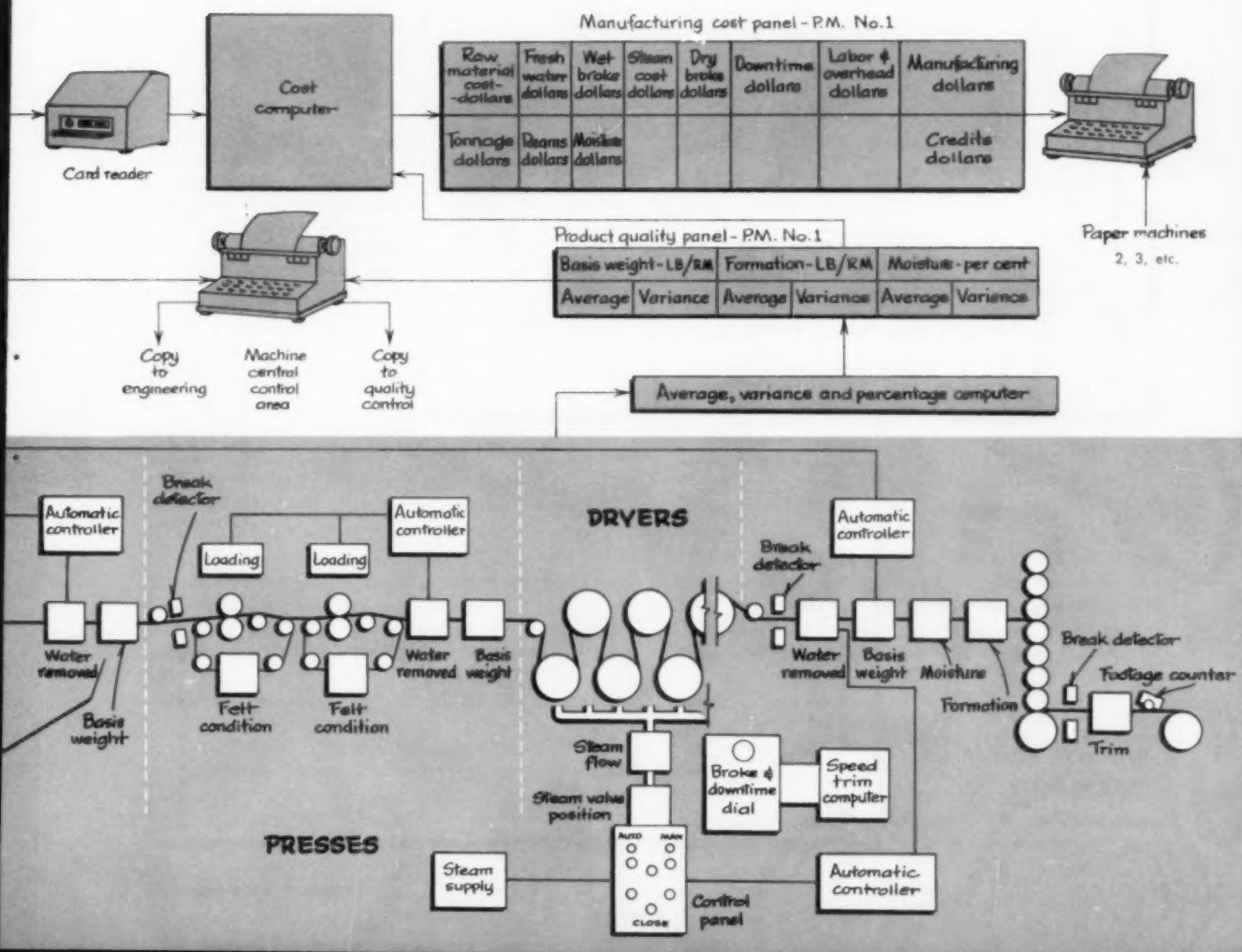
Directly over the slice a basis weight profile indicator is mounted so the machine tender may see the profile being produced, as it is produced. There is also an indication of each slice screw position. It may eventually be feasible to automatically control servomotors on each slice screw from this measurement. Basis weight of paper coming from the wire is gaged and compared with the stock flow to determine the pounds of water removed on the wire per minute. This measurement may be used to control vacuum at an optimum level and also as an indication of the freeness or slowness of the sheet.

In the press section, units measure felt condition in terms of ounces per square foot. Some mill operators believe that greater economy will result through replacement of press felts at a given felt condition, rather than operate with inefficiencies in the press section until a scheduled shutdown. A measurement of basis weight following the presses is compared to the basis weight measurement following the wire to determine the quantity of water removed in the press section. This permits uniform side to side setting of press rolls and may permit automatic control of press loading to some optimum value. Basis weight measurement following the dryer section is used to control the stuff gate automatically, as well as for comparision with the basis weight measurement following the press section to determine the water removed in the dryer section. Since the dryer section is designed to drive out a given number of tons of water for a given Btu input, and since the cost of removing a pound of water in the dryer is eight to ten times the cost of removing it in the press section, the economics are self-evident. This measurement of water removal in the dryer may be used for the control of steam to the dryer section.

On the dry end there is a moisture measurement and a formation gage. The readout of this moisture measurement is to be in pounds per ream as well as per cent moisture. Formation presents an interesting measurement problem because there is no definition of formation, as yet, that can be reduced to a quantitative measurement or a numerical value.

I believe a high speed measurement of the density variations in the sheet can be accomplished, and that this will present a useful measure. Following the stack are break detectors, a width gage to measure trim, and a footage counter.

Since a paper machine is designed to produce a given number of tons of paper at a certain quality level, the readout information is presented in three



sections—production efficiency, product quality, and manufacturing costs. The production efficiency information consists of quantitative data which are compared to goals and the percentages of actuals to goals. Basic information presented includes stock flow; water removed in the Fourdrinier, press, and dryer sections; fresh water flow; felt condition; steam flow; broke at the wet end, dry end and after calendering; causes of broke; downtime; area production; and tonnage. This information is read out visually on a panel and digitally on a typewriter in the form shown in *Fig.* 4 every hour or on a demand basis.

The quantity information is fed through averaging, variance, and percentage computers and similarly read out. Examples of the data presented include basis weight, both average and variance; formation, both average and variance; and moisture, both average and variance. This information is read out digitally by an electric typewriter as shown in the lower section of *Fig.* 4.

Production and quality information is fed to a cost computer together with raw material costs, labor rates, overhead rates, dry broke costs, wet broke costs, steam costs, and fresh water costs to determine process manufacturing costs. The process costs are computed and printed out as shown in *Fig.* 5. The manager thus has before him on an hourly basis, or on demand, current data on costs of raw material, fresh water, steam, wet broke, dry broke, downtime. A summary of manufacturing costs and dollar credits is included so that he may know the accrued costs and credits as they are being incurred.

As more precise and timely information is made available to management, the advantages of data reduction systems will be more widely recognized. This recognition and continuing development in equipment and systems will bring applications of company-wide systems for centralized control of many widely-separated plants.

0800 August 19, 1957

PROCESS EFFICIENCY

	STOCK FLOW TONS	WATER REMOVED - TONS			FRESH WATER	FELT CONDITION - TONS		STEAM
		FOURDRINIER	PRESS	DRIER	TONS	NO. 1 PRESS	NO. 2 PRESS	TONS
Act.	5122.5	6892.0	0770.0	0852.0	2900.3	1250.0	1400.0	0338.0
Goal	5218.6	7090.5	0777.6	0836.2	2900.3	1233.0	1415.0	0331.0
%	0097.2	0097.2	0099.0	0102.2	0100.0	0097.2	0097.0	0102.2

	WET END	DRY END	AFTER CAL.		1	2	3	4	5	6	7	8	DOWNTIME HOURS	AREA PRODUCTION REAMS	TONNAGE TONS
Act.	0007.0	0007.3	0001.5	TONS	0.0	0.0	0.0	3.0	1.3	0.0	8.5	0.0	0001.0	5700.0	0130.0
Goal	0007.0	0003.0	0001.0	HRS.	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4	0001.0	6000.0	0137.2
%	0100.0	0243.5	0150.0										0100.0	0095.0	0094.7

PRODUCT QUALITY

	BASIS WEIGHT - #/MM.		MOISTURE - %		FORMATION - #/MM.	
	AVERAGE	VARIANCE	AVERAGE	VARIANCE	AVERAGE	VARIANCE
Act.	032.3	02.73	007.7	002.0	001.5	01.00
Goal	033.0	01.22	008.6	001.5	001.0	00.75
%	098.0	164.0	089.6	133.3	150.0	133.3

Fig. 4—Sample of report form which can be read out hourly or on demand. Copies of this report would be automatically made available to engineering and quality control departments.

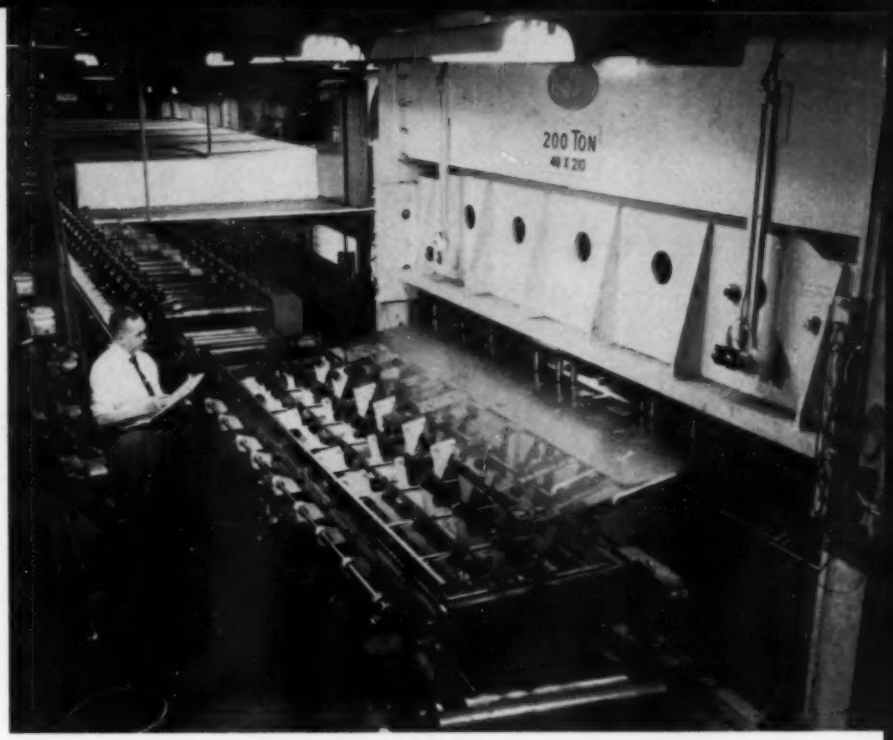
0800 August 19, 1957

MANUFACTURING COST

	RAW MAT'L COSTS	FRESH WATER	STEAM COSTS	WET BROKE	DRY BROKE	DOWNTIME	LABOR & OVERHEAD	MANUFACT. COSTS
	DOLLARS	DOLLARS	DOLLARS	DOLLARS	DOLLARS	DOLLARS	DOLLARS	DOLLARS
Act.	5127.5	0968.7	0338	0112	0704	0800	0300	7851.2
Goal	5218.6	0968.7	0331	0117	0580	0800	0300	7505.3
Diff	0096.1	000000	0007	0005	0.0%	0000	0000	0345.9

	TONNAGE OUT	REAMS CUT	MOISTURE OUT	CREDITS
	DOLLARS	DOLLARS	DOLLARS	DOLLARS
Act.	4700	5700	0600	11400
Goal	4956	6000	0956	11900
Diff	0256	0300	0156	00700

Fig. 5—Management can be automatically provided with this current report on manufacturing costs as the costs are incurred. Corrective measures can be taken promptly so that they can be effective at the time when correction is required.



1

Steel panel for a refrigerator cabinet is caught in a blur of motion as it emerges from a Struthers Wells Corp. blanking press in which notching and piercing operations are done. After changing direction on the transfer device in the foreground, each sheet is fed lengthwise into Yoder Co. forming rolls in the background where flanges are rolled on each side.

AUTOMATION TODAY

MAKING REFRIGERATOR CABINETS

ON AN AUTOMATED WELDING LINE

By **V. C. RICE**, Vice President, Manufacturing and Engineering, Norge Div., Borg-Warner Corp., Muskegon Heights, Mich.

MANUFACTURERS producing products in the highly competitive home appliance market are constantly faced with holding the price line against material and labor cost increases. Few large producers of metal products have to meet keener competition than those who build electric refrigerators primarily for use in private homes. Despite advances in the costs of material and labor, the price line must be held to compare favorably with other competitors' products or the refrigerator manufacturer is faced with the loss of a sizable share of the prospective market. Due to this high competition, the retail price of home refrigerators has advanced very little in the past decade and increasing costs have been met by more efficient production methods and higher productivity through the extensive application of automation.

This point is aptly demonstrated by three new refrigerator production lines recently installed at a Michigan plant of Norge Div., Borg-Warner Corp. Costing approximately $3 million, the three lines represent the largest single investment ever made by this division for production economy through more efficient methods and equipment.

The three production lines produce three basic components that eventually are assembled into an electric refrigerator for home use. The longest line is 150 feet in length, has twenty production stations, and manufactures the outer cabinet of the refrigerator. The second unit performs ten automatic opera-

2

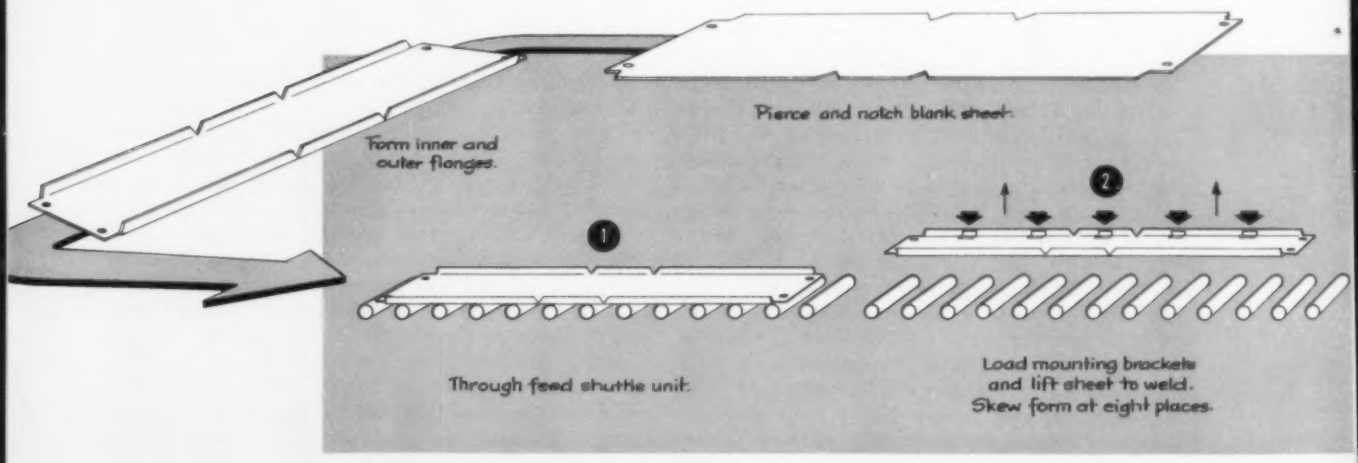
From the forming rolls in the background, steel sheets are transferred horizontally into the first station of the twenty-station United Welders Inc. cabinet forming line. A vacuum cup lift unit transfers each sheet from a roller table onto a through feed shuttle unit. At the next station of the 150-foot line two to five freezer mounting brackets are welded to the inner flange of the flat panel.

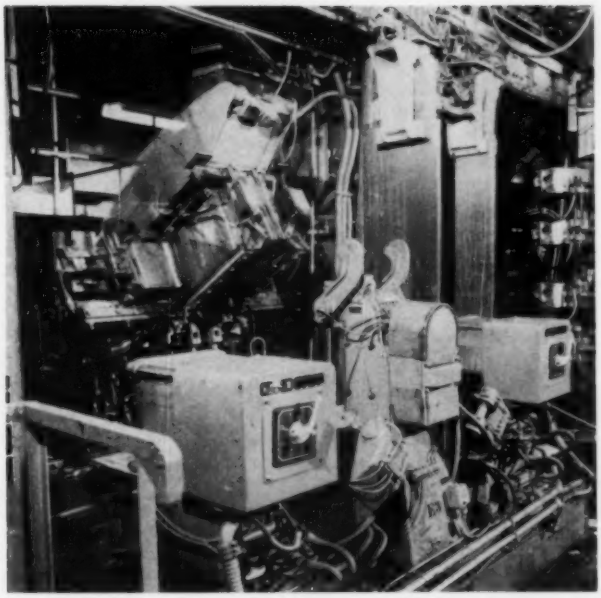
tions on an 80-foot line and makes the food compartment that fits into the outer cabinet. The third line is the shortest (45 feet) and assembles outer door panels (inner door panels are molded plastic).

Flexibility is the keyword in the design of the new lines for they are not confined to producing only one size or model of a refrigerator. Each line not only handles major models and sizes—from single door refrigerators to two door models with separate freezers—but each line can be quickly and easily changed from one model to another. This production flexibility was further extended in the design so that the lines will handle new models contemplated during the next five years with only comparatively minor changes in the production equipment. Amortization of investment is based on this consideration, and it effectively demonstrates that automation is not rigidly restricted to production for a short period or one model year, but, by proper design, can be flexible enough to encompass many model years and amortization over a much longer period than has been thought feasible heretofore.

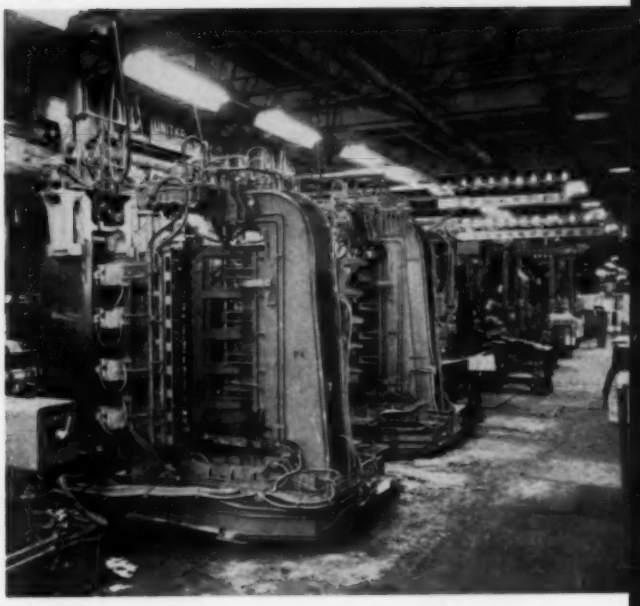
The most interesting of the three lines in terms of equipment integration and automation is the outer cabinet line which is shown in accompanying illustrations. This line makes five different cabinet models at present, and changeover time from one model to another averages 30 minutes—in most cases accomplished by pushbutton. At certain stations where changeover time would be excessive, a second machine has been installed to eliminate changeover altogether. At these special stations, one machine performs operations on three large cabinets, and the second machine does the same operation on two smaller cabinets.

The twenty-station cabinet line may be regarded as a series of automatic welding machines integrated into a continuous production line by transfer equipment between machines and by loading and positioning devices for feeding parts into various sta-


Pierce and notch blank sheet.
Form inner and outer flanges.
1
2
Through feed shuttle unit.
Load mounting brackets and lift sheet to weld. Skew form at eight places.



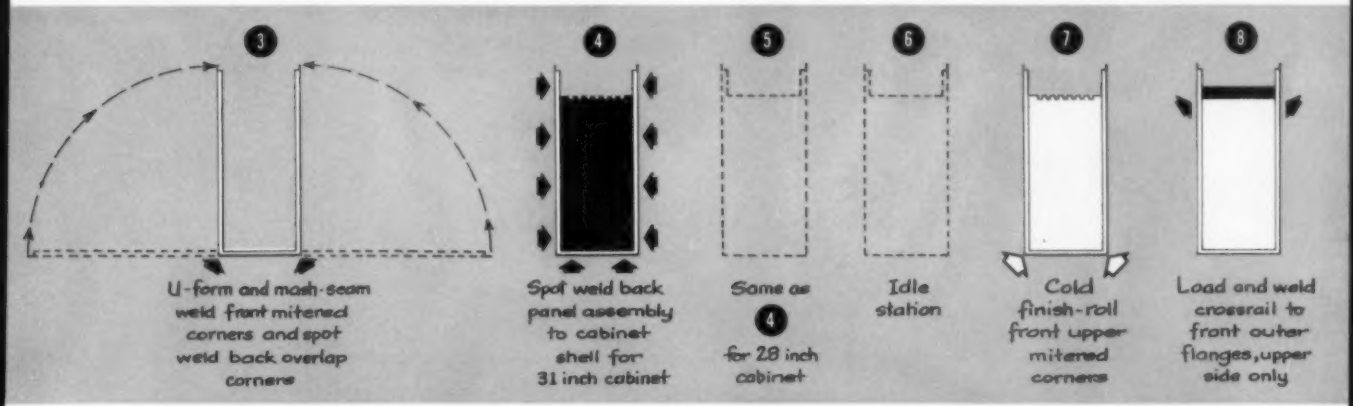
3 After the sheet is automatically transferred to the third station, a retractable inner fixture (upper left) rotates 90 degrees onto the flat sheet. Forming wings on each side bend the flat panel into a U-shape to make the two sides and top of a cabinet. Two seam welding heads and two air-operated welding guns then automatically weld the front and rear corners of the cabinet. After retraction of the inner fixture, grippers clamp the sides of the shell and transfer it by overhead carriage to the next station.

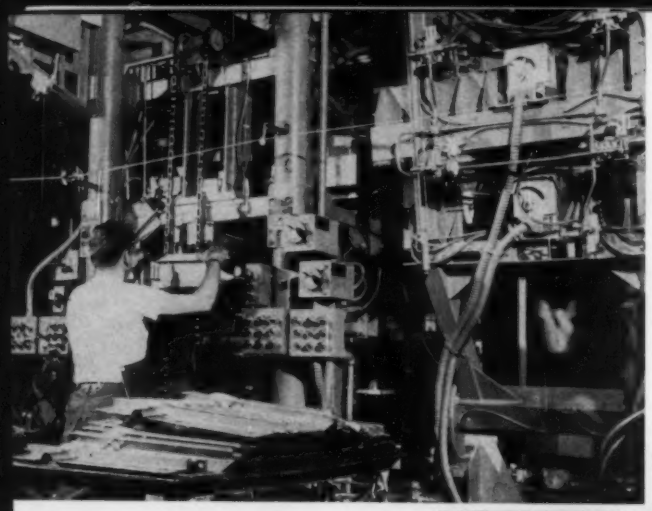


4 Back panel is positioned and welded to the cabinet shell at either the fourth or fifth stations, depending upon which size of cabinet is being processed. Gripper transfer device lowers the inverted shell onto a table and releases it. The table crossfeeds the shell into the welding machine where the back panel has been pivoted into welding position by a two-position fixture. Then 42 air-operated welding guns spot weld the back panel to the cabinet shell as an operator loads another panel onto the second position of the fixture.

tions. All major components of the line were built by United Welders Inc. in close co-operation with Norge engineers who specified the working requirements at each station. Some of the welders in the line also do forming and perform much the same job as could be done by a tangent bender with a supplemental welder.

At each station on the line, there is a fixture that locates and clamps the cabinet and any supplemental parts such as brackets and gussets that are to be added at that station. Where necessary, fixtures can be elevated to more than one working position to accommodate model variations. Welding guns or seam welding wheels are rotated or otherwise brought into position to weld seams and joints automatically, and then retracted. The fixture unlocks, and the cabinet is transferred to the next station. In addition to welding stations, there are


3
U-form and mash-seam weld front mitered corners and spot weld back overlap corners
4
Spot weld back panel assembly to cabinet shell for 31 inch cabinet
5
Same as 4 for 28 inch cabinet
6
Idle station
7
Cold finish-roll front upper mitered corners
8
Load and weld crossrail to front outer flanges, upper side only



5

At the eighth station a crossrail is loaded onto a chain-driven fixture which elevates the crossrail, carries it approximately 3 feet across the top of the welder, and lowers it into position inside the cabinet shell. Two guns spot weld the crossrail to the outer flanges of the cabinet. The cabinet then is shuttled to the next station where other guns apply additional welds to the crossrail.

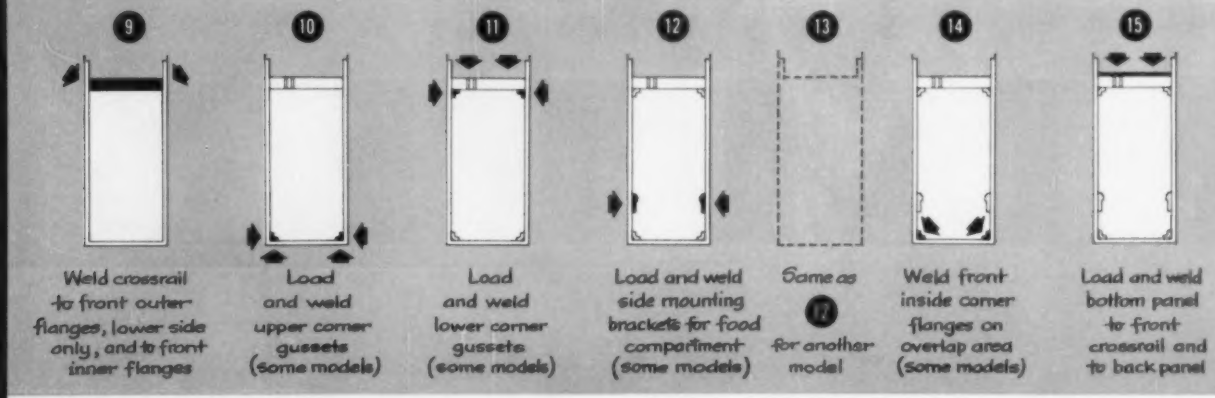
6

The electrical control panels for the automated line are located on a balcony parallel to the cabinet line. A circuit diagram of each station in the line is mounted on the front of one panel in each control group. Pilot lights alongside each diagram indicate the functioning of various subcircuits in the diagram and aid maintenance personnel in locating malfunctions quickly.

other stations where metal forming is performed and where cold planishing of welds is done. At the last station the cabinet is lifted and turned 90 degrees, then rotated down from a vertical to a horizontal position before being released onto an inspection table.

Transfer of cabinets between stations is accomplished by shuttles, slides, or carriages. Some transfer devices have grippers that shuttle back and forth on an overhead track. One of these units is located at Station 3. It grips the cabinet shell after forming into a U-shape, elevates the shell, and moves it to the next station. Action of this and other transfer devices is automatic and takes place in timed relation to other operations.

All units in the line are interlocked to move in correct sequence and without interference. A few motions are controlled by manual pushbuttons, both


9
10
11
12
13
14
15
Weld crossrail to front outer flanges, lower side only, and to front inner flanges
Load and weld upper corner gussets (some models)
Load and weld lower corner gussets (some models)
Load and weld side mounting brackets for food compartment (some models)
Same as 12 for another model
Weld front inside corner flanges on overlap area (some models)
Load and weld bottom panel to front crossrail and to back panel

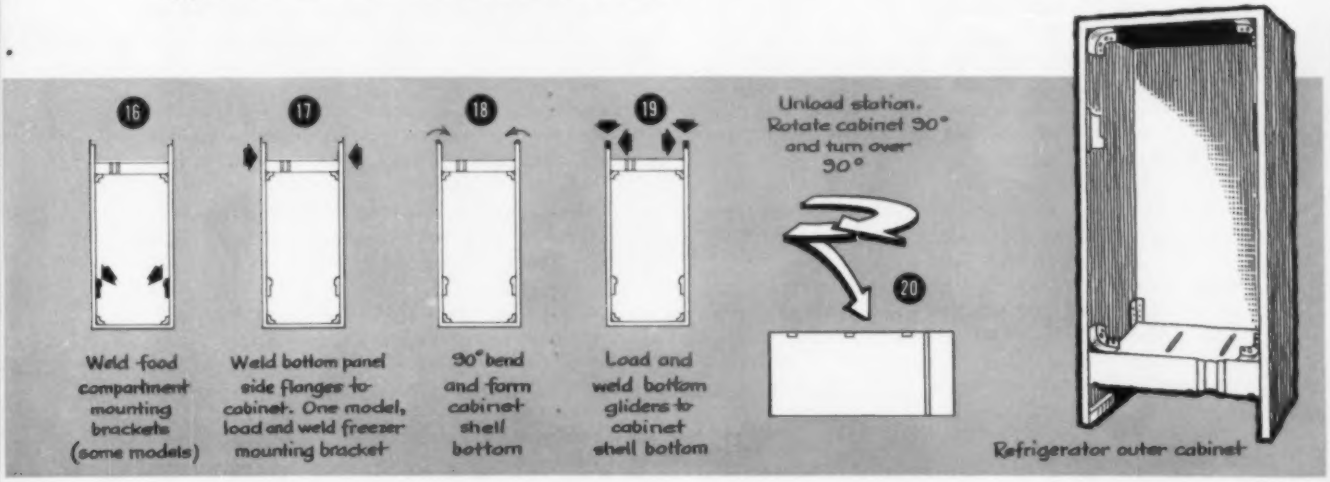
7

At the last station in the line the completed cabinet shell is elevated, rotated 90 degrees about a vertical axis, and then rotated 90 degrees about a horizontal axis. Vacuum cup grippers hold the cabinet during this operation and release the cabinet onto an inspection table. After inspection, the cabinet is conveyed to cleaning and enamel finishing lines.

for operator safety and to give those who must place some parts manually time to do so before the welding components function. Interlocking and operating systems are controlled by electrical equipment, mounted in groups of cabinets on a balcony parallel to the line. Each station in the line has its own group of control cabinets. On the door of one cabinet in each group is a wiring diagram of the station's electrical control system. Checkpoints within the wiring diagram are wired so that the circuit and components can be quickly checked with a test probe and glow light without breaking connections or removing any components. To further aid maintenance personnel, a series of pilot lights is mounted beside the wiring diagram, and these illuminate as various sequences in the control circuits operate. To avoid delay in correcting malfunctions, an electronic specialist and a tool mechanic are on duty on the line at all times.

At certain stations in the line, supplementary parts such as brackets, gussets, and crossrails must be added. These components are hand loaded onto a fixture which is then elevated to welding position. When the welds have been made, the fixture releases the part and returns to floor level for reloading. At the station where the back panel is added to the cabinet, another method of part placement is used. At this station an operator loads the back panel vertically on a fixture which pivots it into position. A table lowers the cabinet shell and feeds it transversely over the back panel. Banks of welding guns then move in to weld the sides and bottom.

All three new lines represent up-to-date automation techniques for this type of work and effect large economies in labor, especially in handling. For example, on the cabinet line only eight men are normally needed to turn out 150 refrigerator cabinet shells per hour. These operators have only to load subassemblies onto the line at various stations and to push operating pushbuttons. From the time the sheet metal blanks enter the line until the finished cabinets emerge and are dropped onto the inspection table, the cabinets are not handled manually. Other large labor economies are experienced on the food compartment line. Normally, only one operator is required on the 13-station line. However, two other men are required to feed strips to a blanking press feeding the line, and an inspector checks the finished compartments as they leave the end of the line.


16
17
18
19
Unload station. Rotate cabinet 90° and turn over 90°
20
Weld food compartment mounting brackets (some models)
Weld bottom panel side flanges to cabinet. One model, load and weld freezer mounting bracket
90° bend and form cabinet shell bottom
Load and weld bottom gliders to cabinet shell bottom
Refrigerator outer cabinet

MAIL PROCESSING

ADVANCES WITH AUTOMATION

The U. S. Post Office Department is being called on to process a rapidly increasing volume of mail. To help meet this demand they are working on automatic machines and equipment to rapidly perform tedious and fatiguing operations so that postal employees can be more effectively employed. A review of some of this equipment includes developments which can also be applied on the industrial scene.

PROCESSING about 60 billion items per year, providing service to more than 175 million customers, employing more than 500 thousand workers, and having yearly financial transactions of 21 billion dollars, the U. S. Post Office Dept. is a major business. Unlike private industrial organizations, the Post Office Dept. has no control over production volumes. Also, the mail being moved must be handled as a perishable, time-value product. There is a critical shortage of post office workroom space, and labor costs are excessive because of manual working of mail. The situation has been constantly aggravated by the rapid increase in mail volume and the great peak loads of mail hitting the post offices in the early evening hours.

In an operation under these conditions one would expect to find in use procedures and equipment representing advanced automation developments. Fortunately this expectation can now be realized at some points in our land. Much of the credit for such advances can be assigned to the Office of Research and Engineering set up after Postmaster General Summerfield decided on a program of modernization. This group is charged with the continuing responsibility of providing department officials with technical assistance in the application of modern engineering techniques to postal operations. A staff of engineers has been gathered to apply available equipment where suitable and to outline the projects for development of special equipment where necessary. Co-operation of other government groups, such as the National Bureau of Standards, has been enlisted and the interest of research and equipment development firms from private industry has been sought.

Members of the staff of the Office of Research and Engineering are engaged in such work as determining the equipment and layout requirements necessary to handle all types of sacked mail (often called bulk mail) speedily and safely; developing new letter and parcel handling techniques, production standards, and procedures; developing functionally designed vehicles for postal operations; and writing procurement specifications. Other staff members are busy writing standard operating procedure manuals and technical instructions, with the expectation that technical training will be provided to postal employees to sharpen old job skills and develop new ones.

The modernization program is a race with catastrophe—the catastrophe of too little equipment, too

This article is based on material supplied by M. B. Feimster, acting deputy director, and L. A. Decker, industrial engineer, Office of Research and Engineering, Post Office Department.

late to handle the increasing mail volume. Even now, much mail is being worked in unsheltered areas, and the employment of mail handling personnel is critical in some cities.

Approximately 30 to 40 per cent of post office workroom floor space is devoted to working parcel post, using only about 5 per cent of the work force. About 75 per cent of the post office mail handling work force is used to work letter-size mail. The best approach to improving this situation appeared to be to attack the parcel post space problem to increase productivity per square foot of floor space, and attack the letter-mail sorting problem to increase manhour productivity.

Adoption of Existing Equipment

Immediate attention was given to surveying post office operations to determine the potential application of common industrial type equipment to bulk mail handling operations. Steps were taken in collaboration with the Bureaus of Operations, Transportation, and Facilities to provide post offices with bundled mail tying machines, various types of fork lift trucks, portable conveyors, and other equipment to facilitate the handling of bulk mail. Expenditures for fixed conveyors, heavy duty portable conveyors, fork lifts, dockboards, skids, pallets, tractors, battery chargers, and other materials handling equipment over a five-year period have amounted to several millions of dollars.

Supplementing the installation of this bulk mail handling equipment, engineering surveys and studies are being made to determine further requirements of industrial trailers, electric trucks and tractors, platform skids, ramps, and dockboards. These studies have revealed some needed improvements and modifications in the existing equipment.

Developing Special Machines

A long range program has been established for mechanization through research and development of machines designed specifically to do post office work. Each function in the sequence of mail operations from collection to delivery was analyzed, and improvement projects were established. Priorities were determined primarily on the principle of "first things first" to effect the greatest cost reductions in the quickest time, within fund limitations.

The major problem still is the predominance of manual performance of physical movements. Improved methods and better scheduling are worthwhile programs, but higher operating economies can be achieved only by using automatic equipment so that mail received at the docks is processed through the culling, canceling, postmarking, and sorting operations by machines.

Culling

When bags of mail arrive at a post office, parcels and letters may be intermixed in each bag. The first process is therefore usually to cull parcels out of the letter mail. Initial development work was begun in 1953 on a prototype device to automatically cull, face, and cancel letter mail. When finally com-

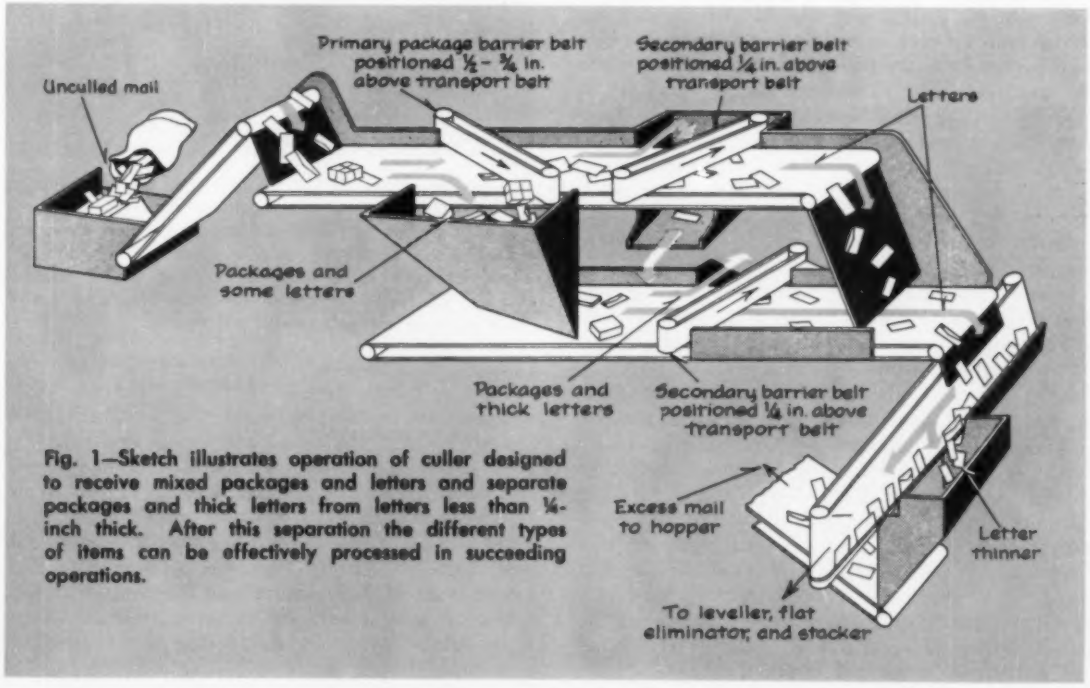

Primary package barrier belt positioned ½ - ¾ in. above transport belt
Secondary barrier belt positioned ¼ in. above transport belt
Unculled mail
Letters
Packages and some letters
Packages and thick letters
Secondary barrier belt positioned ¼ in. above transport belt
Excess mail to hopper
Letter thinner
To leveller, flat eliminator, and stacker

Fig. 1—Sketch illustrates operation of culler designed to receive mixed packages and letters and separate packages and thick letters from letters less than ¼-inch thick. After this separation the different types of items can be effectively processed in succeeding operations.

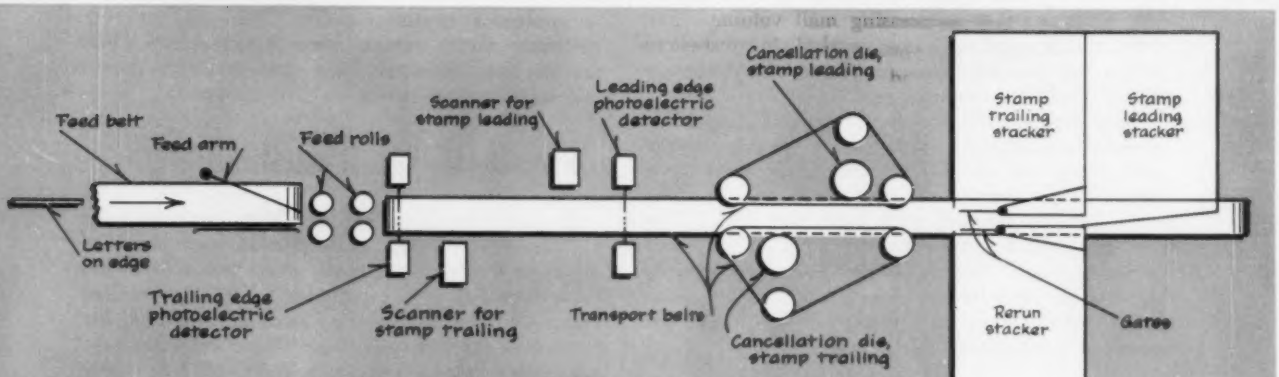


Fig. 2—This diagram is the plan view of a machine to cancel stamps on letter mail and stack letters so address faces can be properly presented for reading and sorting. Shown is a unit designed to process mail 4 to 11½ inches long, 2¾ to 6 inches wide, and 0.008 to ¼ inch thick.

pleted it proved the feasibility of such a development and identified the probable design approach.

Two parallel development efforts are in progress under contracts with Emerson Radio & Phonograph Corp. and American Machine & Foundry Co. One of the two designs will be selected for further improvement and production, or a new unit will be developed incorporating features of both machines. On the prototype models, culled mail will be accumulated in output stackers and manually fed into the facing and canceling stage. The next objective will be to mechanically link the two stages. Present design capabilities are 30,000 letters per hour. This suggests an economic installation in offices processing 200,000 pieces of originating letter mail daily.

Mail is manually dumped from sacks into a feeder hopper on the AMF culler, *Fig.* 1. An elevated belt carries mail upward to a slide and a transport belt. Two barrier belts are positioned at 45 degrees across the transport belt. The first barrier is about ½ inch above the transport belt and sweeps large flats, parcels, and like material off the belt. The second baffle is ¼ inch above the belt and sweeps off thick or bent letters. Passable letters which may be swept off with thicker items have another opportunity to be separated from them on a second transport belt.

Letters from the two transport belts are chuted onto a tilted feeder belt. Surges in volume in excess of 30,000 pieces per hour fall off this belt onto a conveyor which returns the excess mail to the feeder hopper. The feeder belt delivers the stream of letters to an array of belts which thin out and separate the letters into a single file stream. Knockdown fingers, "flat" eliminators, key ejectors, and doubles retarders are included in this array.

In the Emerson culler, sacked mail is also manually dumped into a feeder hopper. An array of three inclined belts spreads and separates the mail into a thin layer, and a weigh pan regulates the stream volume. Mail drops into a 5-channel, V-trough orientation chute which aligns letters and flat articles in a vertical position.

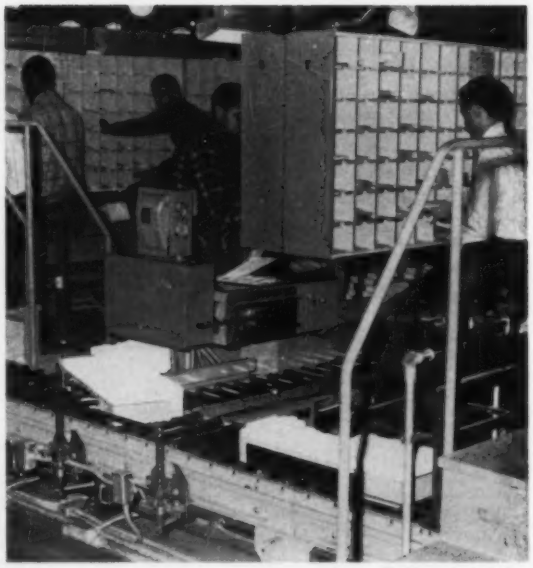


Fig. 3—The mechanical handling system partially shown in this picture was developed to improve manual sorting of letter mail by destination. Faced and canceled letters move to sorting clerks in trays. A cleated belt conveyor running under the sorting cases carries bunches of sorted letters to an assembler who loads them in trays for subsequent processing.

Below the orientation chute is a 5-channel bulk separator which culls out articles greater than ¼ inch thick by means of aperture belts, and drops the thick items on a transverse belt. Thick items are conveyed off as a separate output while thin items drop through the moving aperture belts and are conveyed through an ejector station. The ejecting mechanism diverts mail exceeding 6 inches in height onto a separate transport system. Clean letter mail passes to the facing and canceling operations.

Facing and Canceling

After letters have been culled from the incoming mail, the address faces must be oriented for reading and the stamps canceled. It appears that developments are well on the way to taking the drudgery out of mail facing. In the not too distant future, a machine should be available that is capable of facing 30,000 letters per hour when manned by one or two trained postal technicians. Under present procedures, it takes at least 20 men, working at a steady pace, to manually face and cancel the same number in the same time.

For about six years, efforts have been directed toward the development of a device for automatically performing the facing and canceling function. One prototype was developed and tests were conducted in 1955. Design experience was gained which provided the basis for further contractual efforts. Three firms engaged in this program are Pitney-Bowes Inc., Emerson Radio & Phonograph Corp., and American Machine & Foundry Co. It is estimated that over 100 machines of the types being worked on can be assigned economically in our 50 largest post offices.

In the Pitney-Bowes machine, *Fig.* 2, the flow of letters is controlled by a demand feeder at the input to the machine. Two electronic recognition units scan the lower edge of the document. By relative light reflectance the units determine whether the stamp is on the leading end of the lower edge, the trailing edge, or neither. The scan for stamp leading is initiated when the leading edge of the letter interrupts a light beam. Sensing of a stamp by the scanner for stamp leading actuates one of two canceling dies. If the stamp is on the trailing edge of the bottom of the letter, the reference is the making of another light beam by the trailing edge, and the scanner for stamp trailing actuates the other canceling die. In each case the scanning action is timed to avoid effects from air mail borders, windows, and random inscriptions on the document. Gates in the stacker are actuated to sort the letters into three groups—canceled stamp trailing, canceled stamp leading, and uncanceled. Mail which accumulates in the uncanceled group is manually inverted and rerun.

The Emerson machine applies a once-through approach to facing and canceling. A feeder automatically inserts individual letters into the system with 15-inch spacing between leading edges. Two flying spot scanners with associated circuits scan for stamps as letters pass them. Information on the position of the stamp is stored in a magnetic drum and relayed to the appropriate one of six canceling heads. The canceling head corresponding to the position of the stamp moves out of its normal position to cancel the stamp as the letter moves through this station. The magnetic drum also controls gates which stack the letters into five groups—stamps down, trailing; stamps down, leading; stamps up, trailing; stamps up, leading; and rejects (no stamp or three stamps). Present circuits are designed to recognize only single or double-stamp combinations.

Letter Sorting

After letters are faced and canceled they must be sorted according to their destinations. Under manual procedures, mail sorting is a mass clerical job requiring an army of postal clerks. Several groups of labeled cases are used for each sorting operation. The sorting clerk reads the address, then drops the letter into the correct case. Letter mail sent to a distant city first goes through the "outgoing primary" separation, that is separation by the name of the state to which it is addressed; then

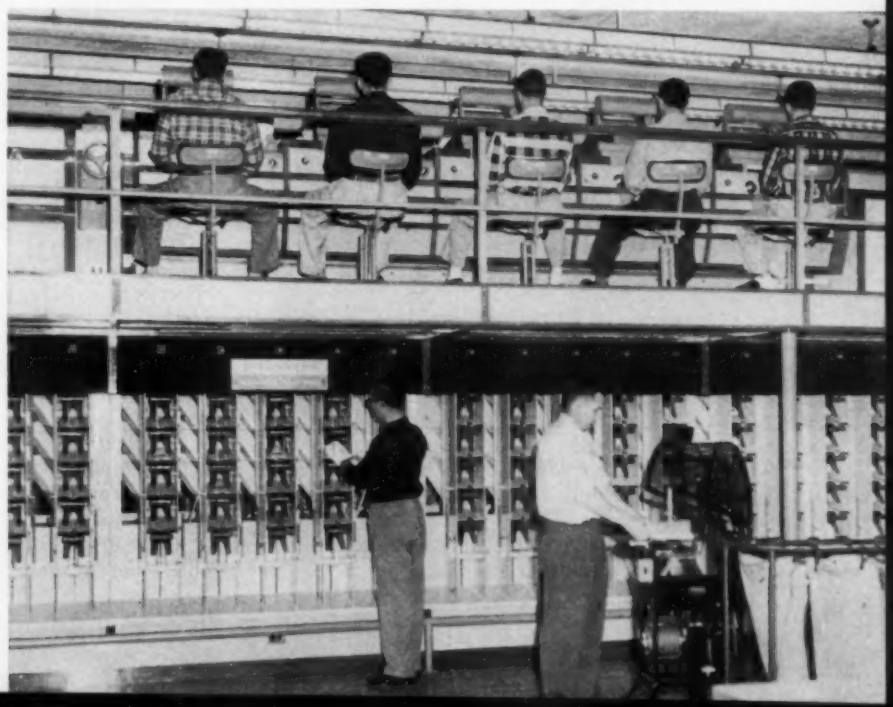


Fig. 4—At Silver Spring, Md., this manually controlled Transorma machine is sorting letter mail into 300 destination receptacles. Addresses are read on faced and canceled letters by operators seated at keyboards. Depressing of appropriate keys automatically controls movement of letters to selected destination receptacle.

Fig. 5—A manually controlled Bell sorting machine is in operation at Washington, D. C. Shown (left) are two of six operator keyboard stations. The operator reads the address and depresses keys designating the destination receptacle. The letter is fed into a transport box which selectively deposits it in a destination receptacle. Shown (Below), letters are taken from these receptacles for further processing.

it moves to the "outgoing secondary" where it is separated by designated cities within that state. When letters reach the destination post office they undergo a "city primary" separation for postal stations and a "city secondary" separation for the individual carrier serving the destination address.

A handling system called the "Mail Flo" system, *Fig.* 3, has been installed in some locations to improve sorting operations. Letter mail which has been culled, faced, and canceled is stacked into plastic trays 24 inches long. The trays are placed on a conveyor and moved to a release and control point. Cases are diverted to auxiliary conveyors along which are manual sorting stations. The postal clerk takes a tray from the auxiliary conveyor and sorts the letters into pigeonholes. A cleated belt also runs past these sorting stations. When a pigeonhole is filled or a signal given over an intercommunication system, the sorting clerks take the letters out of the pigeonholes and put them on the cleated belt. An assembler stands at the end of the belt and puts the groups of letters in trays. They are dispatched on a conveyor for secondary handling. The proper secondary sorting section is identified by a code card fastened to the edge of each tray. The system includes overhead belts for sequential storage of overloads, and for temporary storage of nonpreferential mail.

The volumes of letter mail processed and manpower productivity have generally been determined by linear measurement and the use of multiplier factors. Weight measurement has been recognized as a more accurate method, and automatic weighing equipment has been built for use with the Mail Flo system. The weighing station is in the conveyor system from the outgoing primary section. Each tray is weighed, and information from the coded card on the tray is stored in a recording device. Information is stored as to weight and number of trays en route to any of 35 different destinations. Cumulative data are recorded on tape when a key is depressed.

▸ Letter Sorting Machines

To further speed the sorting of letters, manually controlled machines have been built in which the operator reads the address and keys the destination into a control system. The letter is then automatically carried to a receptacle for the selected destination.

Since April, 1957, a machine of this type called the "Transorma," *Fig.* 4, has been in operation at Silver Spring, Md. Pitney-Bowes Inc., working with Werkspoor N. V., Amsterdam, Holland, supplied this machine.

In May, 1958, a machine, *Fig.* 5, called the "Bell" machine, was put into operation in the Washington, D. C. Post Office. This machine was built by a Belgian subsidiary of International Telephone & Telegraph Corp. Each of six operators sitting at keyboards can sort 3000 letters to 300 destinations every hour. Six operating desks, each equipped with a keyset and an inclined loading ramp on which the incoming mail is stacked, are located

along the side of the machine. Letters are conveyed individually past the operator, who presses keys to send each letter to its destination receptacle. If the operator should punch the wrong code, he has three seconds to remove the letter from the system. If he finds an illegible address, he directs it to a special receptacle.

The distribution section of the machine is built within a large tubular frame. In an endless chain, 626 transport boxes successively pass the operators' desks and each of 300 destination receptacles. Letters are dropped into the transport boxes from the operators' desks and automatically discharged into the selected destination receptacles.

The National Bureau of Standards has been given the task of designing an optimum letter mail sorter suitable for larger post offices and developing such designs through the breadboard stage. The Bureau chose to expand the usable capacity of the keyboard type sorter by adding an electronic destination directory and by separating the keyboard equipment from the sorter proper.

Laboratory mockups for this system have been developed by Rabinow Engineering Co. under a contract supervised by the Bureau of Standards. The keyboard is part of a coding machine, *Fig.* 6, in which letters are individually placed in a reading position in front of an operator by mechanical means. He reads the address and depresses keys which print a coded abbreviation of the address on the back of the letter. The coded destination is recorded by printing selected dots out of a standard pattern of possible dots. The coding machine operator also presorts the letters, by operation of pushbuttons, into four categories—local, outgoing, airmail, or miscellaneous.

The Data Processing Division of the National Bureau of Standards has been working on the development of a suitable code. It has been stated that this code should possess the following characteristics: 1. It should be a universal type applicable to all post offices rather than a code custom made for a given office to accommodate the frequency distribution of mail into and from that office. 2. This universal code should be applicable to both incoming and outgoing mail. 3. The code should employ abbreviations rather than arbitrary code designations. Many codes that exhibit these characteristics have been explored and evaluated. Human engineering tests are being conducted to determine operator coding speeds and associated error rates for the more promising codes.

As indicated by the laboratory mockup, *Fig.* 7, the sorting machine in this system consists of a large number of pockets, on an endless conveyor, into which letters are dropped. Electromechanical equipment controls the dropping of a letter from a pocket into a specified receptacle.

As a letter is fed into the sorting machine, the printed code is scanned by a reading head. The signals from the reading head go to a directory which identifies the desired receptacle for the coded address.

Each pocket on the conveyor has a control rod carrying 12 nylon wheels, *Fig.* 8, each of which can be shifted laterally on the rod into either of two positions. The directory controls a device which shifts the code wheels for each pocket as required. As the conveyor moves, each set of 12 wheels rolls over tracks designed so that when the correct receptacle is reached, all of the wheels drop into depressions and the letter drops from the pocket into the receptacle. The code wheels are shifted back to their normal positions after the pocket is emptied.

The directory is a unit that converts, according to a predetermined schedule, the information from the 64-bit code of the address on the envelope to a 12-bit code for setting the code wheels on each conveyor pocket. The directory uses a stack of 64 thin plates of stainless steel, *Fig.* 9, each about 1 foot square and suspended on edge. Each plate has an individual pattern of holes punched out on a 1/16-inch grid in 12 areas of the plate, and is suspended so that it can be individually moved sidewise 1/16 inch from a normal position by an electromagnet. Behind the stack of plates are 12 phototubes, each of which sees one of 12 areas on the back face of the plate stack. In front of the plate stack is a light source that illuminates the entire front face of the stack. When selected plates are shifted in accordance with the signals from the scanner reading the 64-bit address code, certain of the 12 phototubes receive light and actuate elements to shift the code wheels on the conveyor pockets.

This sorting machine is designed to have several code reading stations in parallel to attain a capacity of 36,000 letters per hour. A contract has been

Fig. 6—Shown is a laboratory version of an address coding machine designed for use with an automatic sorting machine. The operator reads the address and depresses keys in accordance with an abbreviation code. A 64-bit code pattern of dots is then printed on the back of the letter to record the coded address.

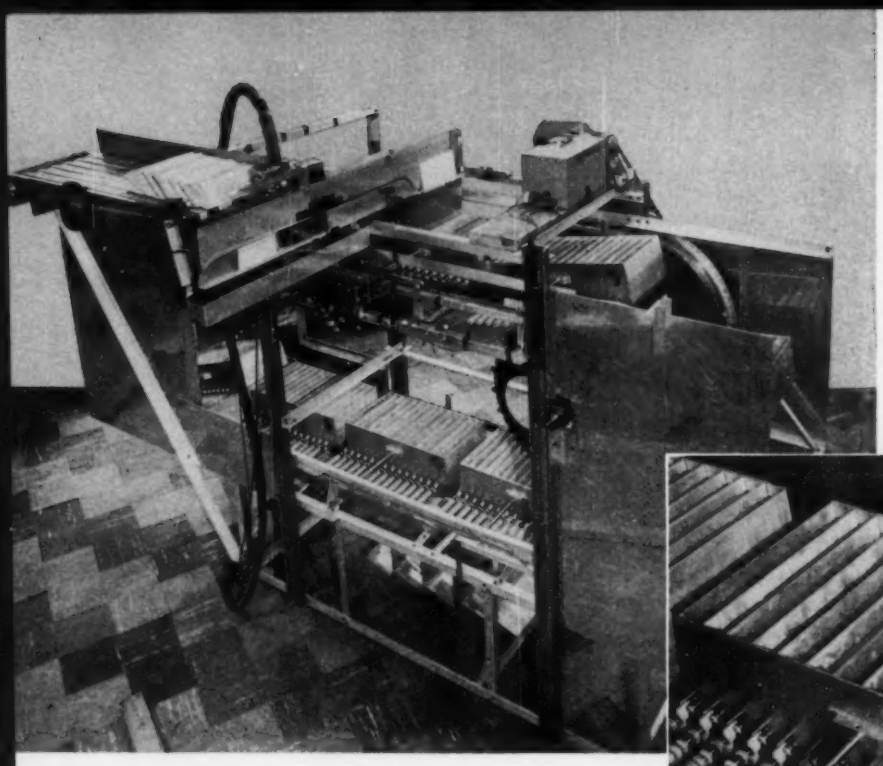


Fig. 7—This laboratory model of an automatic letter sorting machine can automatically read coded addresses and separate letters for different destinations. After the coded address is read, the letter is dropped into a pocket in a handling arrangement for transport to a destination receptacle.

Fig. 8—Each pocket in the sorting machine, *Fig.* 7, has a control rod carrying 12 nylon wheels. For mechanical convenience, 14 pockets are combined in a single carrier unit. Each wheel can be shifted to either of two positions on the rod. These code wheels are set in response to the address code so that the wheels will release the letter when the pocket is over the specified destination receptacle.

let to build such a unit with 1000 destination receptacles. Surveys of postal operations indicate that there are about 55 post offices requiring sorting rates in excess of 36,000 pieces per hour, 16 hours per day, where the assignment of such equipment appears practical.

▸ Automatic Reading

Another development which holds promise is in equipment to automatically read addresses. Two prototypes have been worked up—a presorter and a reader-sorter. The presorter culls out letters addressed in script, window envelopes, and other material which the reader-sorter finds unintelligible. The presorter uses a flying-spot scanner to detect whether the address is readable by the reader-sorter. The laboratory model is said to distinguish "readable" material from "nonreadable" material with an accuracy of 98 per cent.

"Readable" mail is fed to the reader-sorter at a speed of 30 ips. A flying spot scanner is used that can read 300 characters per second with approximately 20 scans per character (when there are 10 characters per inch). Logic in the recognition unit is based upon a division of letters into three classes: 1. Tall (b, d, f, h, i, j, k, l, and p). 2. Three crossing (a, e, s, and z). 3. The g special. The characters c, m, n, o, r, u, v, w, and x are not used but will be if future systems require more information. The characters y and t are subject to excessive variation in size and probably will not be used. The laboratory model of the reader-sorter can analyze and identify "acceptable" mail addressed to 18 destinations. Results indicate that the present criteria are sufficient for a primary sort, but that additional criteria will be necessary to significantly expand the number of sorts.

▸ Parcel Sorting

In the processing of parcel mail, a primary area for improved equipment is in the sorting of the parcels by destinations. Two prototype systems have been developed for postal use. One system called the "Greller" system was supplied by Nelson Laboratories Inc. The second system was developed by Jervis B. Webb Co.

The Greller system has been installed in the Baltimore, Md., Post Office. In this installation, postal clerks mark a destination code on parcels as they load them on a conveyor. As each parcel passes a keying station, the code number on the package is entered on a keyboard and stored in a magnetic tape memory synchronized with conveyor movement. The conveyor runs past drop chutes, *Fig.* 10. Above the conveyor at each chute location is a diverter paddle arrangement. When a

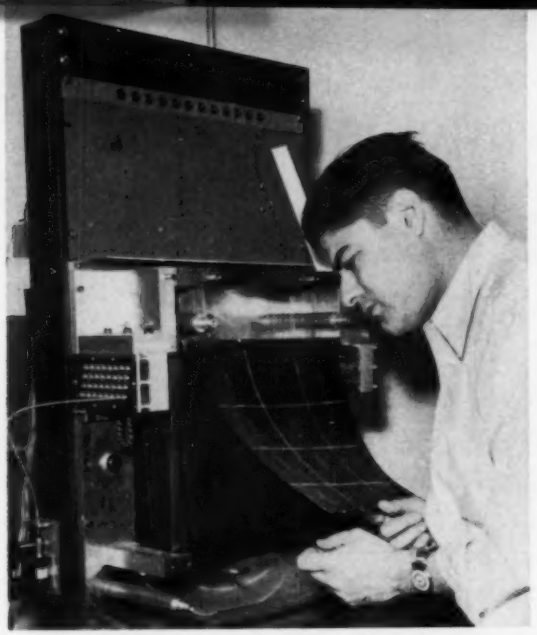


Fig. 9—View shows partially assembled directory unit which converts information from the 64-bit code on the envelope to a 12-bit code for setting the code wheels. Each possible dot in the 64-bit address code is represented by a movable steel plate. Twelve photocells view nonoverlapping areas of the stack of plates. Patterns of holes in the plates admit light to selected photocells as determined by the pattern of dots on the envelope and the preset conversion schedule.

parcel reaches the chute called for as it passed the keying station, the control unit selectively actuates the diverter at that chute. The package then slides by gravity down the chute. Using eight operators, this equipment has a design capacity of 12,000 parcels per hour.

For the Washington, D. C., Post Office, the Webb system will consist of a supply system, eight operator stations, and a distribution system. At the foot of a supply slide will be eight belt conveyors feeding the operators' stations. Adjacent to each station will be a conveyor carrying trays at 27-inch intervals on an endless steel chain. As an operator places a parcel on a tray he will depress buttons corresponding to the destination. A memory system using a series of magnetic discs will be synchronized with the tray conveyor motion. When the tray reaches the appropriate point, the control system will cause the tray to tilt and discharge the parcel to a transverse conveyor belt. Design capacity for each station will be 1200 parcels per hour, and the system will permit 31 separations.

These are some of the interesting equipment developments which the Post Office Department hopes will help it to meet the increasing service demands. In fact, if developments are successful, and are coupled with the most effective transportation media, the goal of next day delivery of letters between any two cities in the United States will be reached.

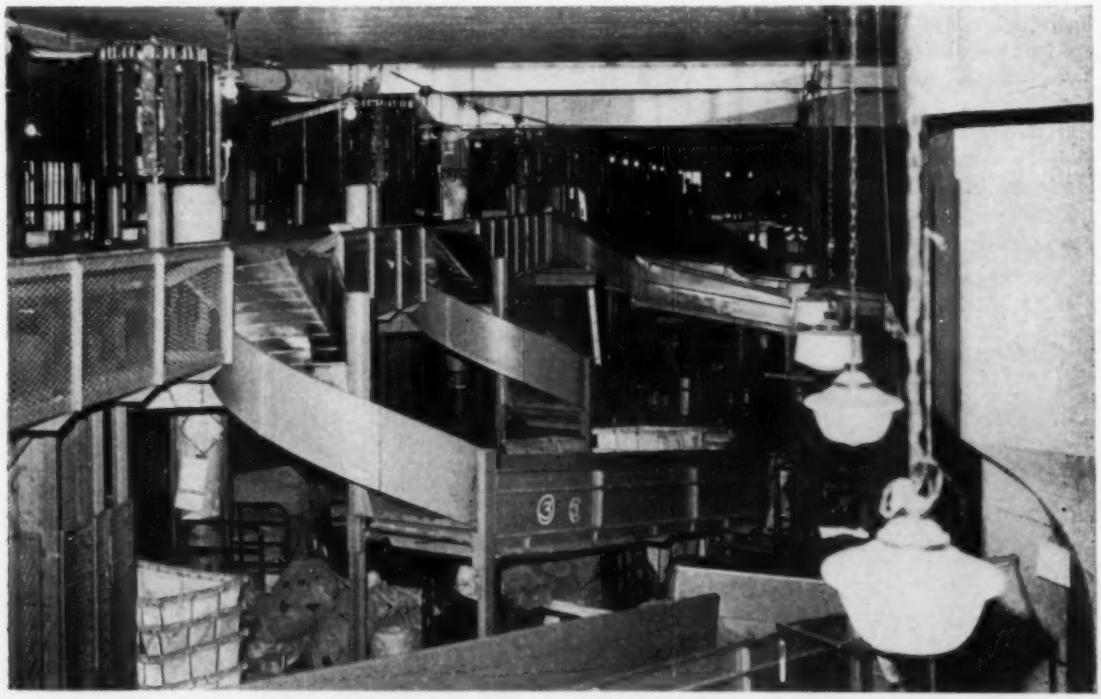


Fig. 10—In this parcel sorting installation at Baltimore, Md., an operator depresses keys on a keyboard to record the destination of parcels moving past him on a conveyor. The destination information is put into a magnetic tape unit which is synchronized with the movement of the conveyor. When the parcel reaches a chute for the selected destination, it is moved off the conveyor by diverter paddles which are moved down to intercept the package.

REDUCE DOWNTIME BY

COUNTERACTING VOLTAGE DIPS

IN INDUSTRIAL CONTROLS

Increasing use of electrical components in complex arrangements places a premium on obtaining uniform voltage supply—and as the author explains, obtaining the requisite uniformity of voltage is a problem to be solved within the plant.

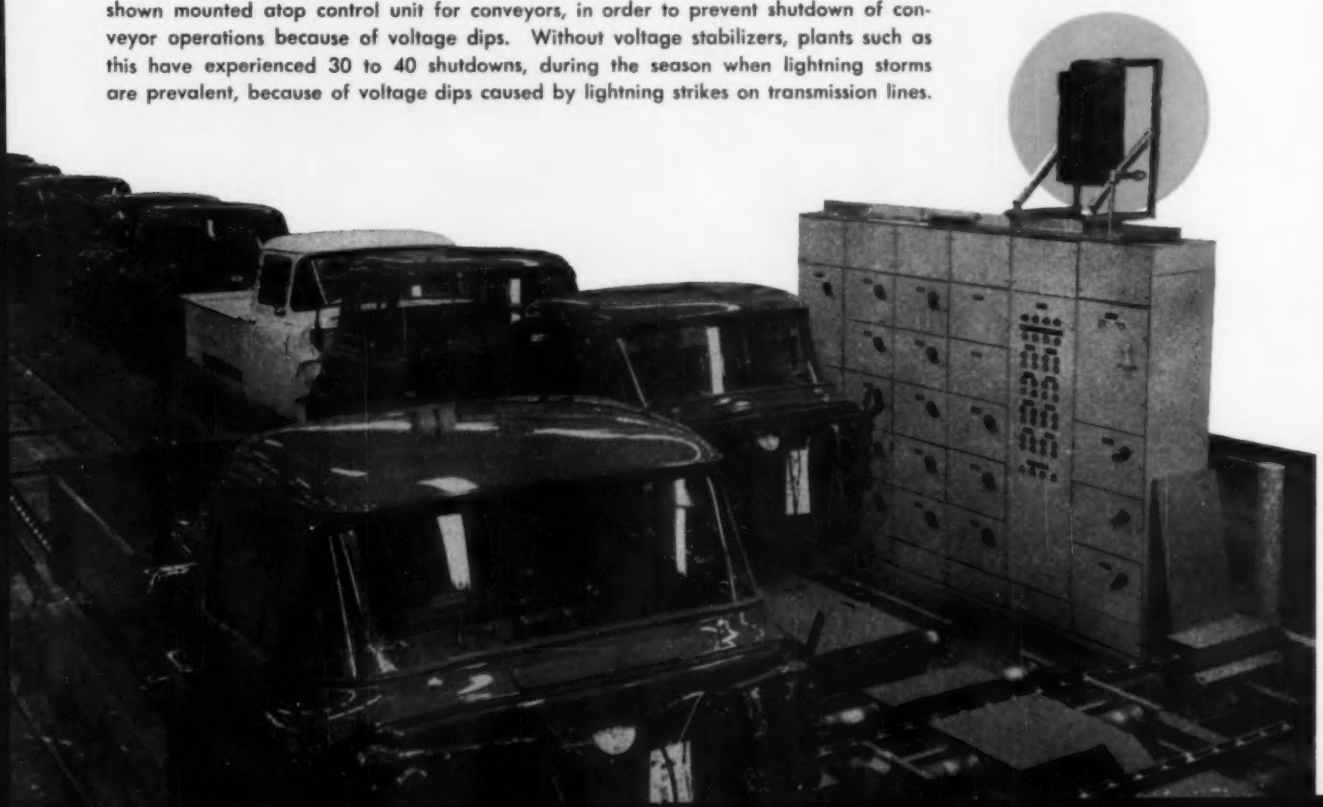
By **G. W. HEUMANN,** Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

CONTINUITY of service has always been an important consideration in electrical power systems. Ideally, there should never be any variation in supply voltage or any interruption in the flow of power. However, this ideal condition can never be attained, and all power systems are subject to disturbances, due to switching surges, lightning strikes, line faults, and the like.

Lightning strikes on transmission lines feeding an industrial power system may cause power system voltage to dip to approximately 30 per cent of nominal voltage. The duration of such dips is the time which the system relays and circuit breakers require for clearing such faults. Depending on type of relays and circuit breakers employed, the duration of such dips may be expected to last from 3 to 15 cycles.

Lightning is not the only cause of transmission

Fig. 1—This automotive assembly plant turned to a voltage stabilizing transformer, shown mounted atop control unit for conveyors, in order to prevent shutdown of conveyor operations because of voltage dips. Without voltage stabilizers, plants such as this have experienced 30 to 40 shutdowns, during the season when lightning storms are prevalent, because of voltage dips caused by lightning strikes on transmission lines.



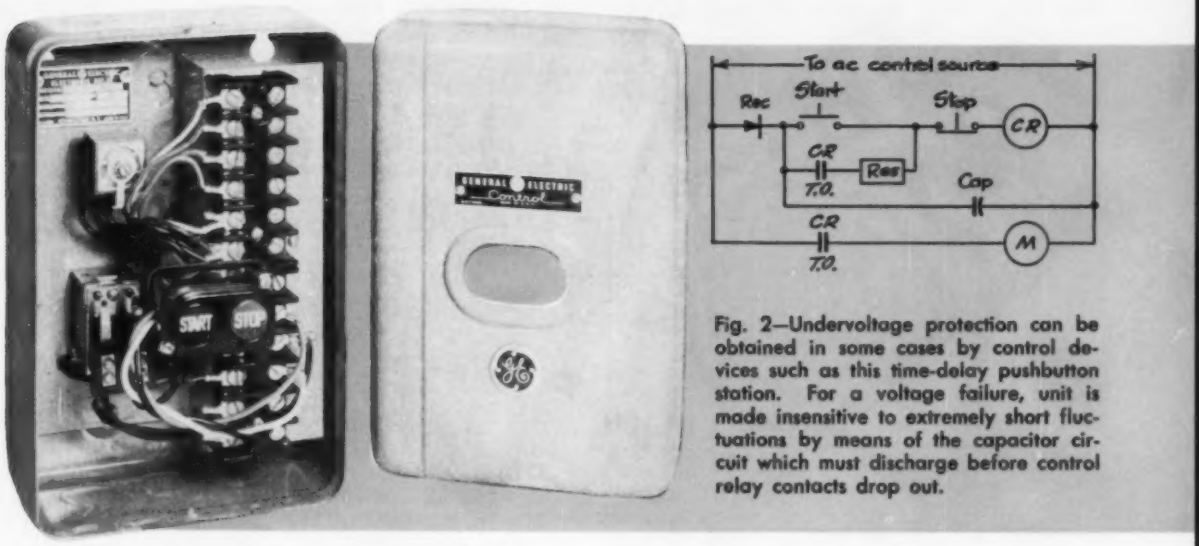


Fig. 2—Undervoltage protection can be obtained in some cases by control devices such as this time-delay pushbutton station. For a voltage failure, unit is made insensitive to extremely short fluctuations by means of the capacitor circuit which must discharge before control relay contacts drop out.

line faults. Arc-overs to ground may be caused by accumulation of dirt and moisture on insulators, mechanical failures, conductor breakage, animals, and many other incidents. Such occurrences will result in similar voltage dips on the system during the time interval required for fault clearing.

In the past, plant shutdowns due to voltage dips have been a nuisance, but not a problem of vital importance. In non-automated plants, the individual machine operators restarted their machines after a stoppage. Some individual automatic drives, such as pumps, compressors, etc., restarted by themselves after the voltage disturbance was over.

In automated plants, individual machines can be integrated in a system of sequentially operated units, linked together by transfer mechanisms, conveyors and the like, *Fig.* 1, which in turn are controlled by magnetically operated contactors, relays, and solenoids. Once this complex sequence is interrupted by a shutdown, it takes considerable time, during which production is lost, before the plant can be started up again.

In a partially automated assembly plant, it was found that, after each shutdown, it took 2 to 4 hours to restart the plant, during which time, several thousand employees were idled. This experience demonstrates that avoidance of a shutdown merits additional capital investment.

▶ Control Performance

Alternating-current magnetic devices such as contactors, relays, solenoids, are designed to close successfully when the voltage at their terminals is 85 per cent of rated voltage or above. However, the design of standard devices does not anticipate any specific value of drop-out voltage. There are no standards and no generally accepted rules. Actual drop-out voltages vary considerably between devices of various sizes and makes. Considerable variations exist between devices of the same size and design, due to variations in tolerances and in wear.

In general, it can be assumed that standard ac devices will not drop out if the voltage stays at or above 60 per cent of rated coil voltage. The devices may become noisy, but they will remain closed. If control voltage drops below that level, they may or may not drop out. Most ac devices will have dropped out if the voltage drops as low as 30 per cent of rated coil voltage. This means any appreciable voltage dip will cause at least some of the ac devices to drop out.

Alternating-current magnetic devices have a very short drop-out time. Relays, solenoids, and contactors controlling motors up to 100 hp at 220 volts or 200 hp at 440 volts, will drop out when the voltage dip lasts for 2 cycles or more. Large contactors which are actuated by dc magnets may remain closed through a voltage dip lasting 5 to 10 cycles. This means that any significant voltage dip, no matter how quickly relieved, will cause drop-out of at least a portion of the control which would be found in an automated plant.

Static switching units operate considerably faster than magnetic control devices. Therefore, they may be sensitive to disturbances lasting a cycle or less. There are no established standards on the voltage variations which can be tolerated by these devices. Products of various manufacturers differ considerably, and the permissible voltage tolerance is a few per cent, not exceeeding 10 per cent. Because of the very short operating time, even very short dips of a cycle or less below the tolerance level will cause malfunctioning of static switching units. Some manufacturers include voltage stabilizing means as part of static switching equipments, to permit the units to ride through voltage dips.

Electronic control equipment is also very sensitive to voltage dips. The degree of sensitivity depends greatly on the design of electronic regulators and sensing devices. Since it is impossible to design a

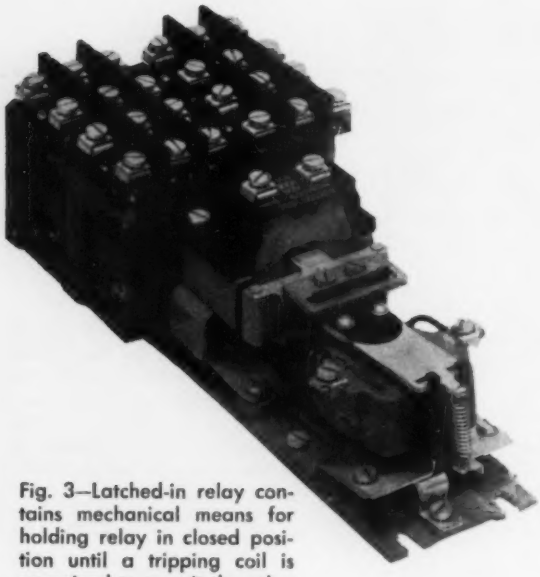


Fig. 3—Latched-in relay contains mechanical means for holding relay in closed position until a tripping coil is energized to permit the relay to drop out. Control action of such a device is insensitive to voltage failures.

power system which is completely free from voltage disturbances, electronic controllers which are vital to the continuity of plant operation may have to be provided with a control power source which is independent of the general power system of the plant.

Production Machinery

Motors will continue to develop torque during a voltage dip, provided the motor remains connected to the power supply. Since motor torque varies as the square of voltage, any significant dip reduces motor torque to such a low value that in itself, it would not be sufficient to keep the driven machine going. However, the energy stored in the rotating parts normally suffices to keep machinery going. A study of a plant exposed to voltage dips of durations up to 15 cycles has shown that production machinery, material handling equipment, conveyors, transfer machinery, and similar equipment were capable of riding through voltage dips with no adverse effects. The Detroit Edison Co. has tested an automatic screw machine, an automatic lathe, and an automatic turret lathe (motors of 30 to 50 hp size) by dropping voltage down to 10 per cent of normal for periods up to 30 cycles. It was found that there was no damage to either the work piece or the tools. These tests are not sufficiently extensive to prove that all types of machine tools can ride through a 30-cycle (or ½-second) voltage dip, nor to indicate what magnitude and what duration of dip will cause damage to tool and work piece. More work will have to be done before a generalized statement can be made on damage expectancy for all conditions of voltage dip and for various kinds of cutting tools. However, it is a fact that many types of production machines are capable of riding through a dip of moderate duration.

A different situation exists on equipment actuated by solenoids. Examples are hydraulic or pneumatic mechanisms or gas-fired furnaces under the control of solenoid-operated valves. Since these valves will shut-off practically instantaneously, any voltage dip will upset the production pattern, and restarting such equipment may be, for safety reasons, a time-consuming procedure.

Induction Motors

Torque delivered by an induction motor is proportional to the square of its terminal voltage. Hence, during a dip, the torque drops rather severely, even when the motor stays on the line. If the torque of the rotating load exceeds the motor torque, the motor speed will be determined by the energy in the moving parts. Motor flux pattern will remain in synchronism with the line voltage rotational pattern, and when voltage goes back to normal, the motor simply reaccelerates to full speed, torque peaks being limited to motor maximum torque (of the order of 200 to 300 per cent full-load torque), and current peaks being limited to locked-rotor current (of the order of 600 per cent full-load current). Hence, riding through a voltage dip is no problem as far as induction motors are concerned when the motor stays on the line.

If the motor is disconnected from the line because of its controller dropping out, the motor ceases to deliver torque immediately, but its flux is entrapped and will decay gradually. While the flux decays, the motor acts as an induction alternator, generating a decaying voltage. If the motor is reconnected to the line before its flux has decayed, and if line voltage and generated voltage are in opposition, high torque peaks of the order of 12 times normal torque may be produced within the motor. If the kinetic energy of the load is smaller than that of the motor armature, torque peaks up to 6 times normal torque may be transmitted through the motor shaft. This is about the limit of torques which the shafts of standard general-purpose motors may transmit. If the kinetic energy of the load is larger than that of the motor armature, peaks of more than 6 times motor torque may be imposed on the shaft, and breakage may occur. Current peaks of the order of 10 times normal accompany the torque peaks. Even if the shaft does not break, the high mechanical stresses in the shaft and in the end-connections of the stator winding may reduce motor life, if they are applied repeatedly.

Large motors may have flux decay time constants of the order of a second, and their indiscriminate frequent reconnection to the line after voltage dips may result in excessively short motor life. However, most motors used in automated manufacturing plants are of smaller size, their time

constants are of the order of a few cycles, and the end-connections of their stator windings are short and comparatively strong; the kinetic energy of the load is usually fairly low. Small and medium-size induction motors in general can be reconnected to the line without any precautions and without significant reduction in motor life.

Synchronous Motors

When a synchronous motor rides through a voltage dip without being disconnected from the line, the reduction in torque may cause the motor to fall out of step. A protective relay will then remove field excitation. The motor may or may not be disconnected from the line, depending on whether the controller is set for shutdown on pull-out or for automatic resynchronizing. When the voltage returns to normal, the motor may reaccelerate and resynchronize automatically.

A different situation exists when a feeder breaker trips ahead of a synchronous motor, and no other loads, or only rather small loads, are connected to the feeder. The motor will then act as an alternator, driven by the energy in moving parts. The controller will stay closed, maintaining dc excitation. Gradually the motor will slow down, and its terminal voltage will no longer be in synchronism with the power system. If the feeder breaker were to reclose and re-energize the motor while it is out of synchronism, severe torque and current oscillations would result, which could damage the motor severely. Synchronous motor applications should be reviewed carefully, and underfrequency relaying provided as needed to disconnect the motor from the power source and prevent its being re-energized while out of synchronism with its field excited.

Undervoltage Protection

Nonautomatic (generally pushbutton actuated) and many automatic drives have undervoltage protection requiring restarting or resetting by an operator after a loss of power. Generally, the undervoltage protection functions instantaneously when the line contactor or the ac undervoltage relay drops out. Time delay undervoltage protection is available, utilizing an undervoltage relay which drops out with a time delay upon a severe drop or a complete loss of voltage. Thus, undervoltage protection would only become effective if the voltage disturbance lasts longer than the adjustment range of the undervoltage relay.

Fig. 2 is a time delay pushbutton station which consists of a Start-Stop pushbutton and a time delay relay mounted in a common enclosure. It is used in conjunction with motor starters which, in themselves, do not provide any time delay upon drop-out. The basic undervoltage circuit is also illustrated in *Fig.* 2. It is based on the capacitor-discharge principle. A single-phase, half-wave metallic rectifier charges the capacitor and supplies control power for control relay *CR*. Pressing the start button energizes relay *CR* which closes, seals itself in, and causes line contactor *M* to close. When ac voltage fails, *M* drops out immediately but *CR* stays closed initially because the capacitor discharges exponentially and circulates current through the resistor and *CR* coil. After a time delay, *CR* drops out. If ac voltage reappears before *CR* has dropped out, *M* recloses immediately and restarts the drive with which it is associated. However, if ac voltage reappears after *CR* has dropped out, the start button has to be pressed again to restart the motor.

Before time delay undervoltage protection is used

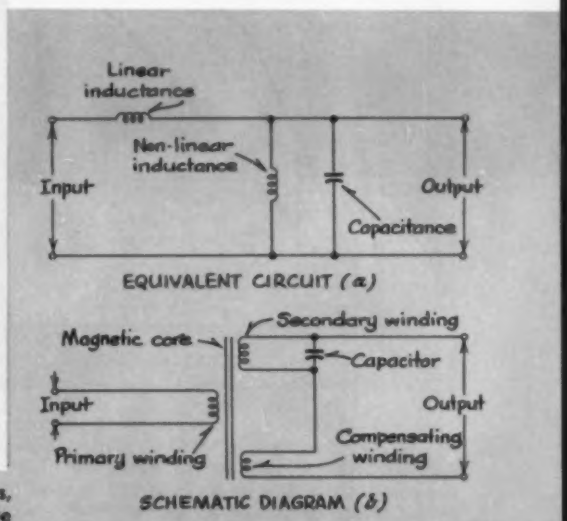


Fig. 4—Standard line of General Electric Co. voltage stabilizers, rated from 15 va to 10 kva. Equivalent circuit of a voltage stabilizing transformer is shown in (a). Actual means of obtaining the equivalent circuit action is shown by (b).

in a particular installation, the following points should be checked: 1. Could the motor or the drive be damaged by re-energizing the motor automatically? 2. Is the power system capable of withstanding the inrush current of all the motors which would restart simultaneously?

Latched-in Relays

Automatic fabricating or assembly plants often employ conveyors and other material handling equipment to transport and position pieces in the various work stations. Control for such equipments may involve rather complex interlocking and sequencing, requiring a considerable number of relays. When conventional control relays are used, a voltage dip may interrupt an involved setup, and considerable time may be lost before the proper sequence is set up again after power comes back to normal.

Latched-in relays may be used to advantage in such a case. A latched-in relay, *Fig.* 3, contains the contact structure and the lifting magnet of a conventional ac control relay. In addition, there is a mechanical latch which holds the relay in the closed position when the operating magnet is de-energized. A second tripping coil, when energized, unlatches the mechanical latch and permits the relay to drop out.

Latched-in relays are impervious to voltage dips, and sequential relay setups are preserved, although the drives associated with the various work stations may slow down or even stop during the disturbance. If automatic restarting is tolerable, the use of latched-in relays is a highly satisfactory method assuring immediate resumption of normal operation after a dip. On the other hand, the fact that a control impulse is needed to drop out a latched-in relay makes the circuit more complex.

TABLE 1
Magnetizing and Inrush Volt-amperes of AC Contactor coils at 60 Cycles

Contactor Size	Magnetizing Volt-amperes	Inrush Volt-amperes
00 (3 and 5 poles)	10 to 22	50 to 110
0 (3 and 5 poles)	20 to 40	90 to 160
1 (3 and 5 poles)	22 to 50	140 to 170
2 (3 poles)	60 to 85	500 to 750
2 (5 poles)	70 to 95	600 to 850
3 (3 poles)	100 to 160	800 to 1100
3 (5 poles)	120 to 180	800 to 1200
4 (3 poles)	140 to 190	1100 to 1800
4 (5 poles)	200 to 240	1600 to 2000

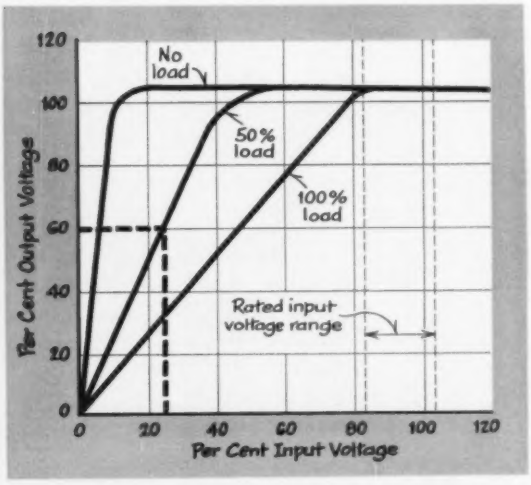


Fig. 5—Output voltage characteristic of voltage stabilizing transformer. The several loads are expressed as a percentage of transformer rating. If load on transformer does not exceed 50 per cent of rated load, it could be expected that ac magnetic control devices would not drop out unless input voltage dips below 25 per cent of rated voltage.

Stabilizing Transformers

A very promising solution to the voltage dip problem is the use of voltage stabilizing transformers in the control circuit. Such transformers are available in standard ratings from 15 va to 10 kva. They utilize a nonlinear network consisting of inductance and capacitance to the effect that a large change in input voltage corresponds to a considerably smaller change in output voltage. In appearance, they resemble standard dry-type transformers, *Fig.* 4.

The principle of voltage stabilizing transformer action is illustrated by the circuits of *Fig.* 4. The equivalent circuit is shown by *Fig.* 4*a*. A linear inductance is in series, and a network consisting of a nonlinear (saturable) inductance and a fixed capacitance in parallel with the output. With such an arrangement, the output voltage (over a certain range and under certain load conditions) stays practically constant with considerable variation in input voltage impressed on the network. *Fig.* 4*b* illustrates how the equivalent circuit is realized in the actual transformer design. Leakage inductance between the primary and secondary windings provides the linear inductance. The secondary winding and the magnetic core provide the nonlinear inductance. A compensating winding adds to the voltage stabilizing effect.

Fig. 5 is a plot of output voltage versus input

voltage for various loads expressed as a percentage of transformer rating. The character of the load, especially its power factor, has some effect on the output voltage. However, since we are interested in the behavior of the voltage stabilizing transformer under a severe voltage dip condition, the effect of power factor is of a minor order and may be neglected.

If the input voltage is reduced to approximately 25 per cent of rated voltage, an output voltage of approximately 60 per cent of rated voltage would be maintained if the load on the transformer does not exceed 50 per cent of the transformer rating. If the ac control circuits of magnetic control devices were supplied from such a transformer, it could be expected that contactors and relays would not drop out unless the supply voltage dips to below 25 per cent of rated voltage during a disturbance.

One criterion for selecting the proper size of a voltage stabilizing transformer would be that the kva rating of the transformer should not be less than twice the total magnetizing kva of all contactors and relays connected to the transformer secondary side. The transformer rating thus determined should be checked by a second criterion which considers the overload imposed on the voltage stabilizing transformer by the inrush kva when the contactors and relays are energized. The inrush kva is considerably larger than the magnetizing kva. Since voltage stabilizing transformers have little overload capacity, and since their output voltage drops rapidly when the load exceeds their rating, care must be taken not to overload the transformers by the inrush kva. As fluctuations in ac line voltage are to be expected, it is desirable not to have additional drop in the voltage stabilizing transformer. To check this point, proceed as follows: Determine the maximum inrush kva with which the voltage stabilizing transformer may be loaded. Select the worst case by considering the largest number of devices which may pick up simultaneously on top of the largest number of devices already energized. The kva thus determined should not exceed the kva rating of the voltage stabilizing transformer.

There are no standards governing magnetizing and inrush volt-amperes of the coils of contactors and relays. Coil data have to be obtained from the control manufacturer. Some manufacturers publish control power requirements in their control catalogs. As a guide for estimating, a range of magnetizing and inrush volt-amperes of standard ac contactors is listed in TABLE 1. Control power requirements of general-purpose relays are about the same as those of size 00 contactors. This tabulation is not all inclusive, but standard general-purpose contactors now on the market can be expected to fall within the limits listed in the table.

▶ Summary

Voltage dips will occur in the best-managed power systems; they have to be accepted as unavoidable. On drives which are not essential, let motors be stopped and restart them by hand, this will permit the use of standard controllers.

When stopping and automatic restarting is permissible, a simple solution is the use of time-delay undervoltage protection. Automatic restarting occurs after a dip or a complete interruption of power up to several seconds. Scrutinize drive and power system characteristics to determine whether automatic restarting is permissible for a given installation.

Complex control sequences can be preserved in case of voltage dip or complete power interruption for an unlimited time by using latched-in relays. Their use adds to complexity of circuit design.

Voltage stabilizing transformers maintain voltage on the control circuit through dips, but they are of no benefit during power outages. Voltage stabilizing transformers provide a simple and economical method of permitting automated plants to ride through short-duration voltage dips, provided the production machinery is capable of doing so.

overnight data transmission

MANUFACTURING a full line of metal dining furniture in its Los Angeles plant, Virtue Bros. Mfg. Co. distributes its products from inventories stored in commercial warehouses in scattered locations across the country. Previously the central records for production control and accounting functions were updated by information transmitted by mail. A revised data handling system based upon Bell System teletypewriter service is now used.

As orders are received at the warehouses, invoices are prepared by combining standard customer information on a prepunched tape with details that are typed manually by a clerk. As a byproduct, simultaneously with preparation of the invoices, all of the information is punched on a paper tape that accumulates data for all transactions that occur.

At the close of each day, the summary roll of tape is placed on a Cycle Equipment Co. unwinder with the head of the tape threaded into teletypewriter transmission unit.

Sometime during the night, an operator at Virtue's Los Angeles office dials each warehouse number and the transmission unit automatically processes the tape containing complete invoice information.

Duplicate invoices are prepared on the receiving teletypewriter and, as a byproduct of the duplicate preparation, a special tape containing selective information is made. This tape is subsequently run through an IBM tape-to-card punch, which automatically punches cards for accounting purposes.

INTEGRAL HANDLING DEVICE AUTOMATES FORGING PRESS

AUTOMATIC FORGING of hot steel bars into crawler track links for tractors is being accomplished at Erie Foundry Co. The setup, *Fig.* 1, heralds a breakthrough in forging technology that is expected to extend to manufacture of connecting rods, gear blanks, valves, and other forged products in a variety of fields. Heretofore, forging has been a manual operation.

Applied to company's 2500-ton mechanical forging press, an automatic handler powered by the press receives hot bars from a furnace and advances them step-at-a-time through the machine, *Fig.* 2. A pusher first positions a bar at a pickup station. From the pickup station it is advanced progressively to a semiforging die, a finish forging die, and an ejection chute. Transfer is effected by a pair of parallel arms that contain three sets of pickup fingers. Operation is synchronized with the stroke of the press.

Biggest problem in the 2-year development was to devise means of handling the high-temperature (2000-2400F) parts. Solution lay in providing maximum clearance in the die area for the transfer arms and in extending the pickup fingers inwardly toward the work. Fingers are of die steel in the form of spaced, parallel plates that close in above and below the flash surrounding the parts. Purpose is to grip the body of the work when it is lifted by knockout pins, and not depend upon uncertain flash configurations. Form of the fingers is suited to the part being forged.

A single operator monitors the automatic process, which presently produces 1200 finished forgings per hour. In contrast, conventional operation of a press this size requires two operators and produces approximately 350 parts per hour. Addition of a trimming die station is possible following the finish forging station. The trimming station would eliminate the need for two or three trimming presses normally required to trim flash from the parts.

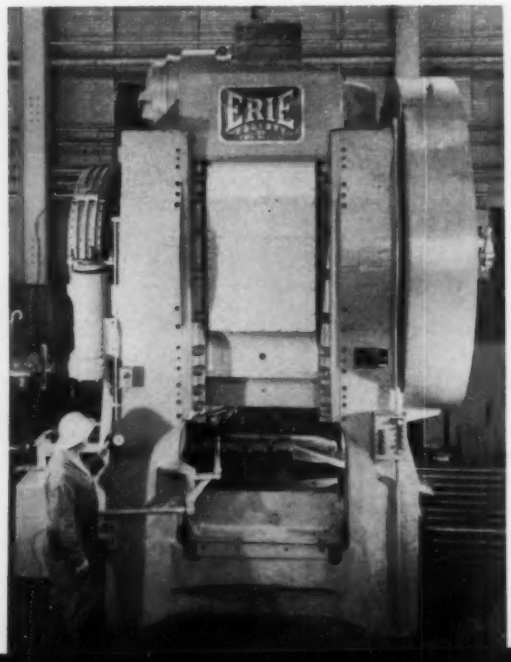


Fig. 1 — Mechanical forging press built by Erie Foundry Co. is equipped with automatic handling device that receives hot steel bars from a furnace and advances them through die stations to produce crawler track links for tractors. Production rate is 1200 forgings per hour.

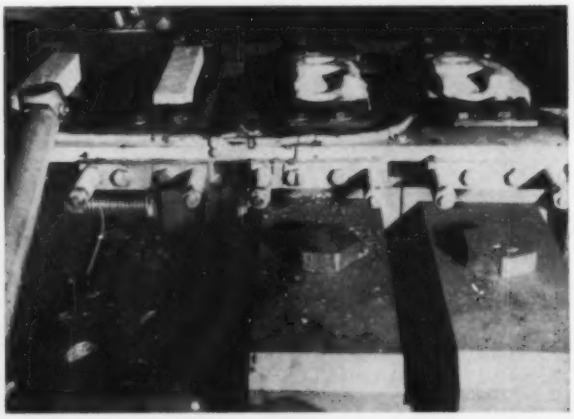


Fig. 2—Close-up of die area shows progress of parts through press. Hot (2000-2400F) steel bars are placed in a pickup station by a pusher and are then transferred progressively to a semiforging die and a finish forging die. Ejection is also automatic.

METER–RELAY CONTROL

OF BALL GRINDING PROCESS

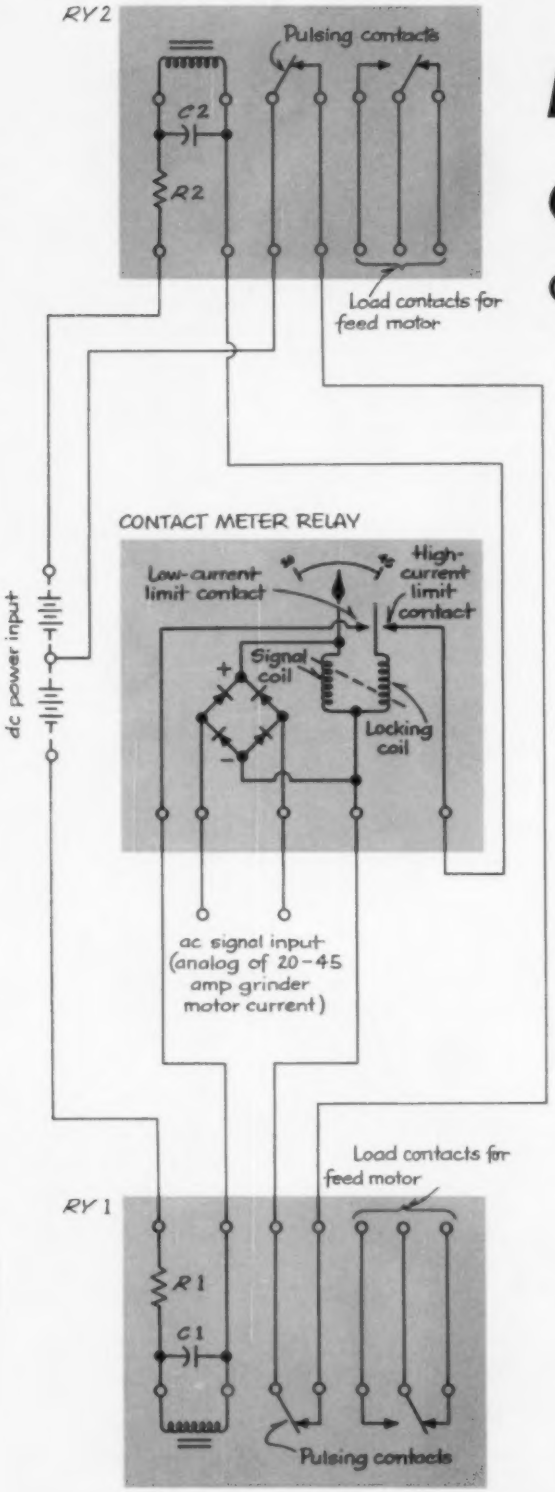


Fig. 1—Simplified schematic diagram illustrates major circuit elements employed in fixture-positioning controller for steel ball grinding machine. A pulsing arrangement enables meter-relay to sample grinding wheel motor current conditions during corrective process.

AUTOMATIC CONTROL of grinding of steel balls within diameter limits of plus or minus 0.0005 inch is accomplished with a relatively simple electrical circuit, *Fig.* 1, that employs contact meter-relays and load relays. Current drawn by the grinding wheel drive motor, which is a gage of grinding pressure, is used as the control parameter.

A transformer connected between the motor starter and the grinding wheel drive motor provides ac signals indicative of the current drawn by this motor. These signals are fed to the controller, *Fig.* 2, where they are used to control the operation of a feed motor that determines the position of a circular, vertical workholding fixture with respect to the vertical grinding wheel face. Grinding motor currents of 28 amperes or more cause the fixture to be retracted from the wheel, and currents of 23 amperes or less cause the fixture to advance. Motion is effected through a screw mechanism associated with the feed motor.

The grinder control circuit was developed for a metalworking plant by Assembly Products Inc. who also supplied the relays and a dc power supply. Operation of meter-relays was described in detail in a previous issue of AUTOMATION.*

Circuit Details

In operation, ac analog signals from the current-sensing transformer are fed to the input terminals of the contact meter-relay, *Fig.* 1. They are rectified to dc before being applied to the signal coil in the meter-relay. This instrument has a suppressed zero scale that begins at 20 and extends to 45 motor amperes. With normal grinding motor currents of 24 or 25 amperes, no control actions are initiated. If, however, this current should decrease to or below 23 amperes, indicating that grinding pressure is too light, a low-current limit contact in the meter will be made.

Making of the low-current limit contact completes a circuit from one terminal of a dc power source through resistor *R*1, the coil of load relay *RY*1, the locking coil of the contact meter-relay, normally

*Paul Saint-Amour, "Use Meter-Relays To Monitor And Control," AUTOMATION, Vol. 3, No. 12, Dec. 1956, pp. 74-78.

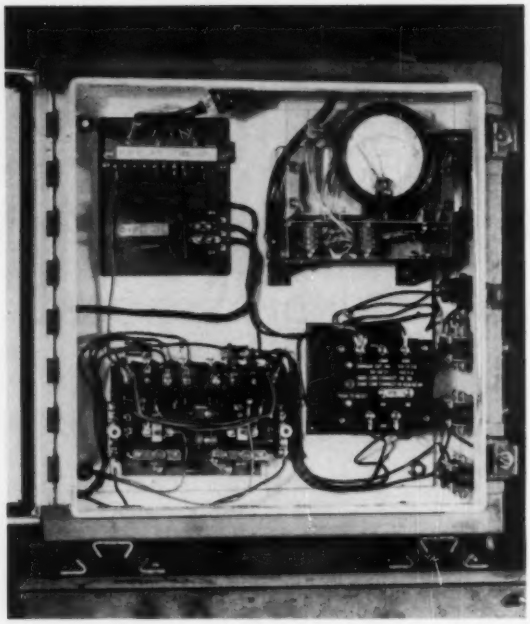


Fig. 2—Controller uses a contact meter-relay, upper right, and two load relays to correct position of motor-driven workholding fixture relative to grinding wheel face. Control signals are ac analogs of grinding wheel motor current, obtained from a transformer. Ball diameters can be held within limits of plus or minus 0.0005 inch with this arrangement.

closed pulsing contacts in load relays *RY*1 and *RY*2, and back to the opposite terminal of the power source. The power source, shown as a battery for simplification of the diagram, is actually a dual full-wave rectifier power supply incorporated in the controller.

When current builds up in the coil of load relay *RY*1, the unit operates, and its two sets of relay contacts are actuated. The normally closed pulsing contacts open, and a set of load contacts makes. Opening of the pulsing contacts breaks the circuit to the power source and the locking coil of the contact meter-relay is de-energized. Operation of the load contacts starts the feed motor in a direction to advance the workholding fixture toward the grinding wheel.

▶ Pulsing Action

Ordinarily, opening of the pulsing contacts of load relay *RY*1 would result in de-energization of the coil of this relay and it would release instantly. However, it is kept energized for a short time after this occurrence by receiving the charge on capacitor *C*1 that shunts its coil. This capacitor had previously received a charge during the initial closed-circuit condition set up when the low-current limit contact in the meter-relay was made.

The effect of this holding action is to keep the feed motor operating to apply corrective positioning of the workholding fixture and to free the contact meter-relay so it can respond to grinding motor current changes that result from fixture movement.

When the charge on capacitor *C*1 dissipates sufficiently, load relay *RY*1 releases. If grinding motor current has been restored to the normal range during the previous held-in period of load relay *RY*1, no further action occurs. If, however, the motion of the workholding fixture during this period has been insufficient, the contact meter-relay will again lock in and the pulsing cycle will repeat until grinding motor current is restored to its normal range. Generally a single pulse will suffice to effect correction.

Pulsing frequency is a function of the values of *R*1, *C*1, and the characteristics of the load relay used. In the circuit shown, *R*1 is 3300 ohms and *C*1 is 20 mfd. Interruption occurs twice a second.

The circuit for retracting the workholding fixture on excessive grinding motor current is similar, except *R*2, *C*2, and load relay *RY*2 are involved and screw rotation is in the opposite direction as a result of making of the high-current limit contact in the meter-relay. Since the load relays are identical, and the values of *R*2 and *C*2 are the same as those of *R*1 and *C*1, the pulsing rate is the same for both corrective processes.

This arrangement provides close control of positioning of the workholding fixture and serves to prevent the screw from rotating too far in either direction. As further protection against the latter, limit switches are used. A manual override switch permits manual adjustments to be made based on meter readings.

Before the automatic controls were installed on a number of machines, operators periodically noted the load on meters and manually adjusted the grinding pressure. A complete machining cycle from rough to finished work required 8 hours. This cycle has been reduced to 6 hours with the advent of automatic controllers.

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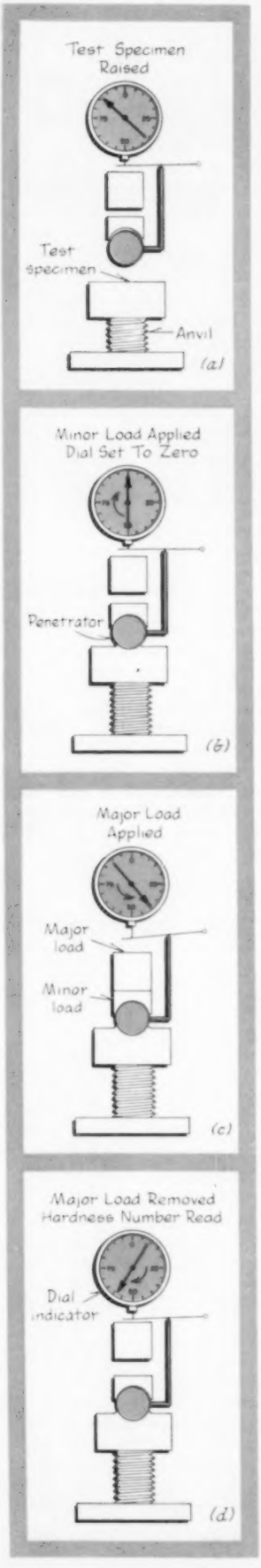


ADD SPEED TO PRECISION BY

TESTING HARDNESS AUTOMATICALLY

Speed and versatility have been added to hardness testing by the development of automatic testing equipment. With this addition, the manufacturing engineer has gained another automated technique to increase the efficiency and output of the integrated production line.

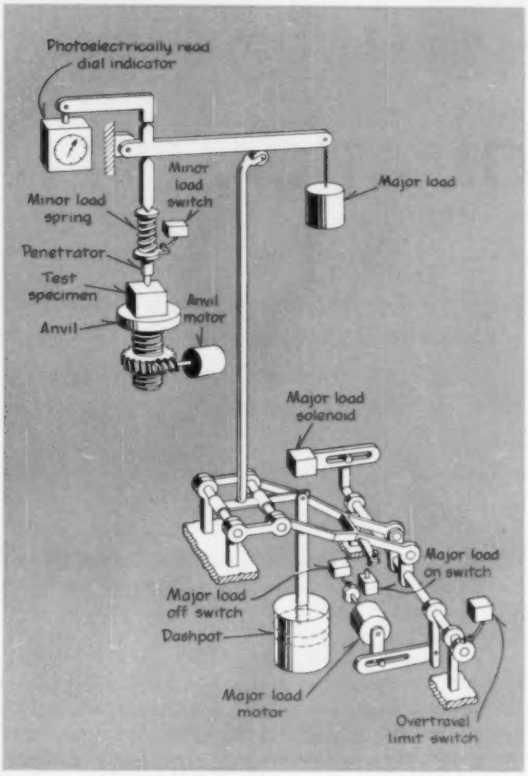
By **VINCENT E. LYSAGHT,** American Chain & Cable Co. Inc., New York, N. Y.

TESTING of metallic materials for mechanical properties has long been considered a manual job to be delegated to special technicians in a laboratory remote from the manufacturing floor. However, to keep pace with the industrial trend of faster production on more and more automatic machinery, manufacturers of testing equipment have applied the elements of automation—processing, handling, and control—to the design of their equipment. Now such equipment can be used directly on the manufacturing floor, adjacent or in-line with other automated equipment, and still maintain the precision and accuracy experienced in the remote laboratory. One such material test that has been automated to a high degree is the hardness test for use on ferrous and nonferrous metals. In the past, output from manual hardness testers in the laboratory averaged 200 to 400 tests per hour. Today, the latest development in Rockwell hardness testers is capable of automatically testing material at a rate of 1000 to 1200 tests per hour. In time, these testers will become standard equipment for high speed hardness testing in manufacturing plants, particularly those engaged in automotive, aircraft, and bearing work.

Hardness is an undefinable property which finds wide practical application when it is correlated with service experience or some property or characteristic of a metal. In the broadest sense as applied to metals, hardness is the cohesion of particles on the surface of the metal as determined by its capacity to scratch another, or itself be scratched. In metallurgy, hardness is that resistance

Fig. 1—Sketch illustrates the principle of operation of the Rockwell hardness test. Test specimen is placed on anvil as in *(a)* and then elevated until it touches the penetrator. A minor load of 10kg is applied to indent the test piece and to insure a well-defined point from which to start measuring the penetration of the test load. The dial-indicator is then adjusted to zero or the set point *(b)*. A major load of 60, 100, or 150kg, depending on the expected hardness of the material, is then applied *(c)*, and removed leaving the minor load still applied *(d)*. Hardness number, read from the dial-indicator, is a relative hardness value which is proportional to the change in indentation of the penetrator as the major load is applied and removed.

TESTING HARDNESS AUTOMATICALLY



to indentation of a given material, compared to that resistance offered by other materials. This limited meaning can be condensed into the accepted phrase of "indentation hardness." In usage the word "indentation" is generally implied, and the word "hardness" is used alone. Unlike other physical conditions such as temperature, pressure, humidity, and electrical phenomena, hardness has no basic standard reference.

Automatic hardness testing has tremendous application in the metalworking industry. It is generally conducted to determine the suitability of a material to fulfill a certain purpose or function. The test can be used to grade and classify metals, to check the uniformity of metal, or to relate the hardness of the metal to some other physical property. For example, some metals are brought to a desired performance level by either heat treating or cold working. Such treatments change the original metallurgical structure of the metals, and through hardness tests, it is possible to quickly

Fig. 2—Automatic hardness test cycle is started when anvil motor raises test specimen to penetrator. Penetrator indents specimen, causing minor load spring to compress and actuate switch. This switch stops the anvil motor through an adjustable timing circuit. Dial-indicator is now at its zero set point. Major load solenoid is energized causing the major load to be applied at a rate determined by the dashpot setting. When major load is fully applied, limit switch on lever arm actuates motor to remove major load. Cam-operated switch on motor closes when major load is fully removed, energizing the photoelectric reading circuit connected to the dial-indicator.

FACTORS AFFECTING ACCURACY OF HARDNESS TESTING

ACCURACY of hardness testing is dependent on many factors that can affect the indentation hardness of metallic materials under test conditions. For example, since one point of hardness on the Rockwell scale represents a penetration of only 0.00008 inch, extreme care must be exercised in performing the test. Often, special jigs and fixtures must be designed to hold the part under test since a vertical shift of only 0.001 inch, as the major load is applied, will cause an error of over 10 Rockwell numbers.

Great care and good judgement must be exercised in outlining hardness specifications. Limits which are too close tend to place an unnecessary hardship on material producers and may be beyond the ability of testing equipment to duplicate results in suppliers and receivers plants. Limits which are too wide may result in passing an inferior product. For example, if material is desired within a Rockwell hardness range of C55 to C60, limits should be set between C55.5 and C59.5 since in this range Rockwell testers will agree to within plus or minus ½ of a Rockwell point. As softer materials are tested, hardness limits should be widened since larger impressions are obtained and a greater tolerance is required in testing equipment.

In conducting hardness tests, it is essential that all of the test specimens be properly prepared. No burrs are permissible on the surface on which the test is being made. Scale and deep marks must be removed from the surface under test. Care must be taken so that work hardening of the test surface is not introduced during preparation of the specimen. The specimen must be homogenous unless the test is being conducted to determine decarburization, segregations, or inclusions. The grain size of the test specimen must also bear proper relationship to the size of indentation.

Although these factors may seem to be incompatible with high production on automatic testing equipment, equipment manufacturers have been able to design automatic testers which are sensitive, accurate, and remain in calibration for long periods of time. Proposed installations should be discussed with these manufacturers for their recommendations.

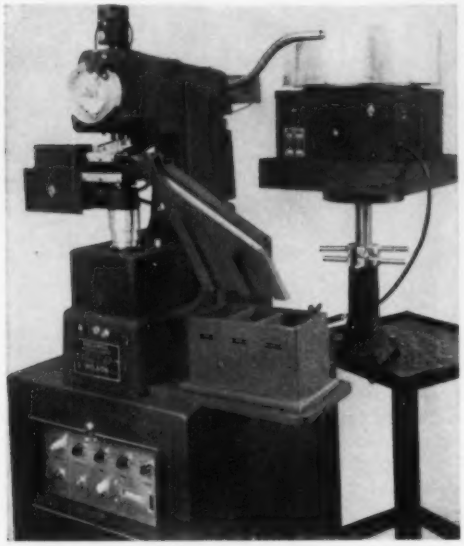


Fig. 3—Automatic Rockwell hardness tester is fed parts from a vibratory hopper and discharges tested parts into classification bins according to hardness value measured.

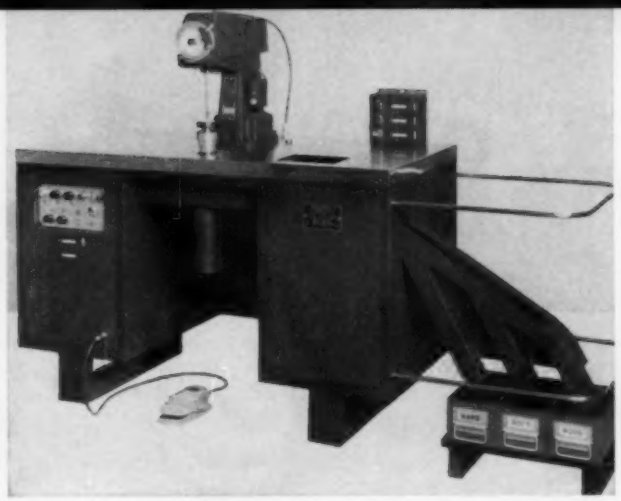


Fig. 4—Console model of Rockwell hardness tester will classify up to 1000 hand-fed parts per hour. Photoelectric classification circuits in tester automatically open gates in disposal chute to allow tested parts to fall in proper classification bin.

inspect and classify the amount of change. Under certain conditions, the field of hardness testing may be extended to indicate machinability, toughness, wear resistance, fatigue strength, etc. In the final analysis, hardness testing is considered by experts as a must in practically all manufacturing operations and as a necessary tool or process in the inspection of metals in fabrication stages.

Rockwell Hardness Testers

There are several different hardness test methods used in industry. One method that is commonly used is the Rockwell test. A simplified sketch of a manual Rockwell test is shown in *Fig.* 1. The same principle of operation is used in automatic Rockwell testers manufactured by Wilson Mechanical Instrument Div., American Chain & Cable Co. Inc. except the application and removal of the minor and major load are accomplished by automatically controlled motors and solenoids, *Fig.* 2, and readout of the dial-indicator is performed by photoelectric cells. The photoelectric readout circuit can be set to react within hardness limits as close as 2 Rockwell points. A light source mounted outside the dial-indicator case is directed toward a prism located on the pivot arm of the indicator needle. This prism transmits a beam of light toward the periphery of the dial. When the major load motor has removed the load and stopped, a classification circuit is energized and the reflected light source actuates one of three photelectric cells set at the limits of the material being tested. Depending upon which cell is actuated, parts are classified as *Too Soft, Satisfactory,* or *Too Hard.*

An automatic Rockwell hardness tester is shown in *Fig.* 3. In this floor model type, parts are loaded into a vibratory hopper which automatically feeds them through a tube to a loading device. An electrically actuated rod pushes the parts one at a time into testing position and simultaneously pushes a tested part out of testing position and into an unloading chute. With the untested part resting on the machine's anvil, the minor load is applied automatically, the major load is applied and removed, and the difference in indentation is measured by photoelectric cells on the dial-indicator. When the piece is ejected from the test position into the disposal chute, gates actuated by the classification circuit allow the part to fall into the proper classification bin.

A console model of a Rockwell hardness tester is shown in *Fig.* 4. With this instrument it is possible to automatically classify up to 1000 tests per hour on large production runs by hand feeding individual pieces of work. By making a simple change in anvils, this unit can be set up to test materials that vary in thickness from 0.030 to 6 inches.

In any consideration of automatic hardness testers, it must be kept in mind that different companies utilize hardness testing instruments for different purposes. Therefore, what may suffice for one manufacturer, such as hardness tolerance limits, speed of test, or depth of penetration, may not be satisfactory for another. Some manufacturers use the hardness test for inspection of incoming materials while others use it for process control. The great use of the various types of hardness testers—portables, hand units, floor models, and automatics—emphasizes the need for equipment that is properly designed, rugged, and has lasting precision. Such equipment is available from manufacturers. Proper use of this equipment will reduce inspection time, improve product quality, and materially add to plant automation.

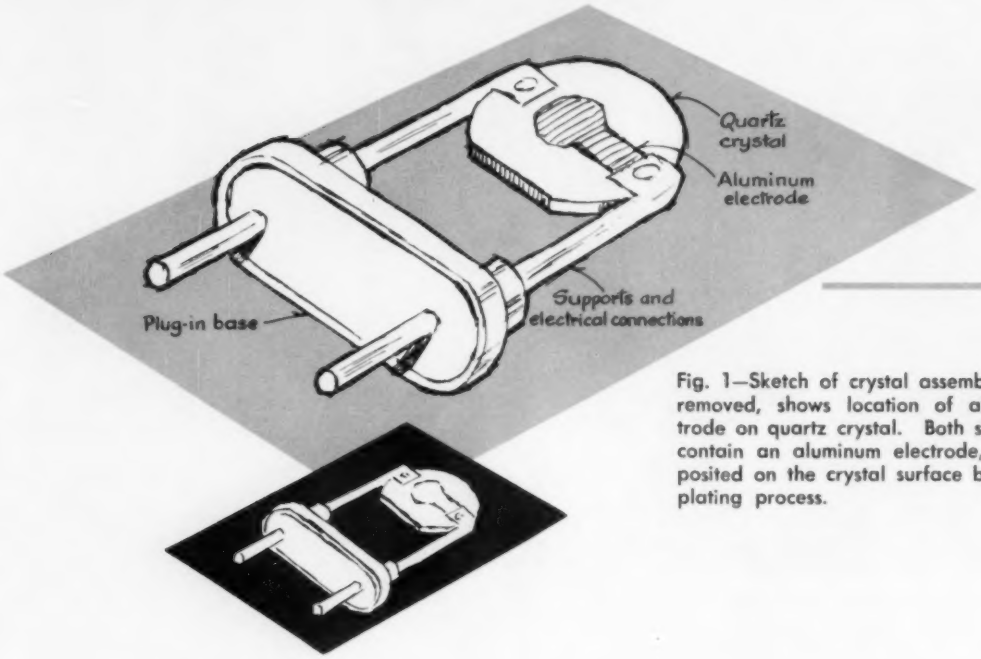


Fig. 1—Sketch of crystal assembly, with cover removed, shows location of aluminum electrode on quartz crystal. Both sides of crystal contain an aluminum electrode, which is deposited on the crystal surface by evaporation plating process.

SPECIAL EVAPORATION PLATER

RESULTS FROM AUTOMATION PROGRAM

By **KENNETH LiDONNICI,** Senior Engineer*, Bulova Research and Development Laboratories Inc., Woodside, N. Y.

PRESENT-DAY methods of quartz crystal manufacture utilize highly trained operators to achieve the precision demanded in these important components of communication equipment. Expansion of crystal production, therefore, would normally be dependent on how quickly and how successfully the necessary operator skills could be acquired. Of military significance, the utilization of special automatic machines in place of skilled manpower permits a more rapid transition into higher production in addition to improving the uniformity of the product.

This reasoning has led the U. S. Army Signal Supply Agency to sponsor a production engineering project, with Bulova Research and Development Laboratories Inc., with the goal of mechanizing the manufacturing processes necessary for the production of CR-18/U and CR-23/U quartz crystal frequency control units, *Fig.* 1.

Previous articles† have described development of the plans for this production engineering project as well as certain automatic equipment which has been developed as a result of those plans.

In addition to those processes previously described, another for which a special machine has been developed involves the evaporation plating of aluminum electrodes onto each side of the circular quartz blanks. These electrodes provide an electrical connection between the piezoelectric quartz frequency standard and the communications equipment employing the standard.

The area, location, and thickness of the aluminum electrode, or base plate, must be very carefully controlled if the characteristics of a crystal are not to be affected. As an indication of the type of problem involved, it should be remembered that the quartz discs are either 0.375 or 0.490 inch in diameter, and vary in thickness between 0.004 and 0.016 inch. Of the several means available for depositing aluminum on quartz, the method which has proved best is by evaporation plating in a vacuum chamber.

The main elements of the evaporation plating equipment, *Fig.* 2, include: 1. Holders that contain a number of quartz crystals in such a manner that only the portion of each side of the blank to be

*Subsequent to submitting this article for publication, the author joined Fairchild Camera & Instrument Corp.
†References are tabulated at end of article.

Under government sponsorship, development of special automatic equipment for quartz crystal manufacture continues. The evaporation plater described in this article is one of many special machines developed by engineers in accordance with over-all automation goals established several years earlier.

plated is exposed. 2. A vacuum chamber containing the mechanism for supporting and rotating five holders, and a hopper arrangement for storing and feeding aluminum charges. 3. An induction generator for providing the heat necessary to melt and evaporate the aluminum charges. 4. A mechanical vacuum pump for "roughing" down from atmospheric pressure to 200 microns of mercury. 5. A diffusion type vacuum pump for further reducing the pressure in the chamber down to 0.3 micron of mercury. 6. Control circuits which provide for automatic cycling of the equipment and stages in the plating process.

▶ Operation Details

At the start of an operating cycle, the operator manually loads a nest consisting of five holders onto the fixture in the vacuum chamber. When an *Automatic Cycle* button is actuated, one of a pair of solenoid operated wafer switches indexes, permitting electrically-operated valves in the pneumatic system to position for a roughing stage (in *Fig.* 2 valves *A*, *C*, and *D* are closed and valve *B* is open). A thermocouple gage-tube in the vacuum chamber senses the pressure reduction, and indicates a voltage change on a millivolt meter-relay calibrated in microns of mercury. The meter relay is set at 200 microns, and when that point is reached, a rotary solenoid indexes the wafer switch to the fine vacuum phase (valves *B* and *D* are closed and valves *A* and *C* are open).

When the pressure is reduced to 0.3 micron, a second meter-relay, actuated by a cold cathode discharge gage, signals completion of the fine vacuum phase and pulses an air cylinder. The air cylinder actuates a hopper feed mechanism causing an aluminum ball to be dropped into the crucible, *Fig.* 3. Simultaneously, with this action, the air cylinder also causes the individual crystal holders of the nest to rotate through 180 degrees. Because of the

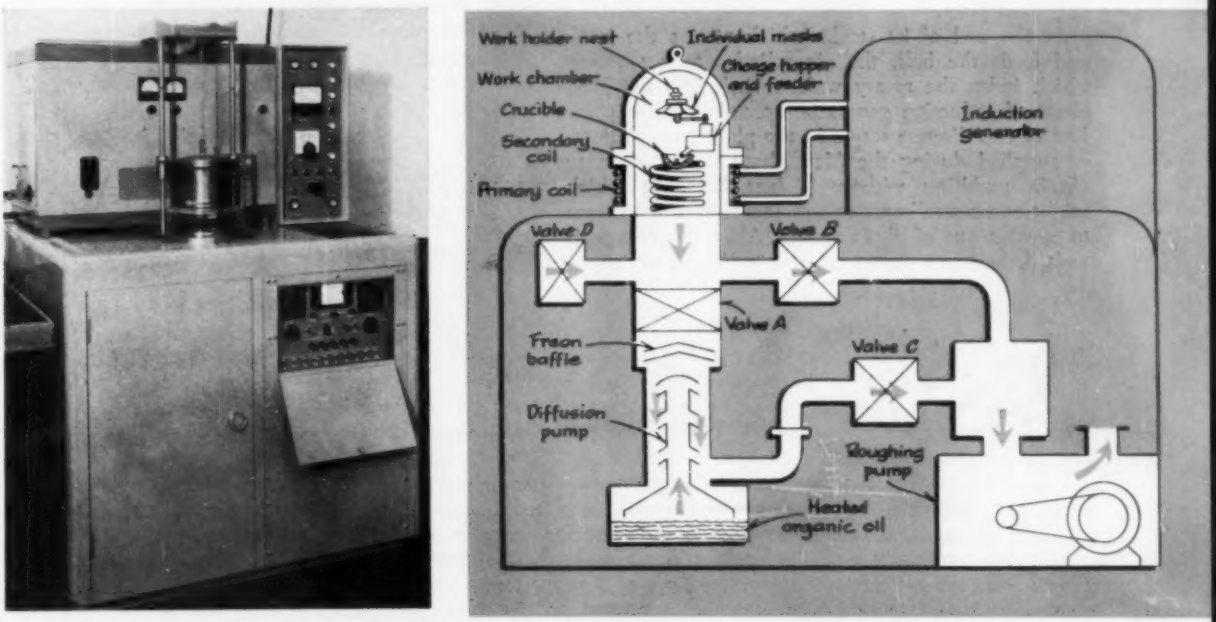


Fig. 2—Schematic diagram illustrates main elements of automatic cycling equipment. Typical nest consists of 5 masks which hold crystals, exposing portion of each side of crystal that is to be plated. Masks are automatically rotated to present both sides of crystals to plating source without breaking the vacuum in the work chambers.

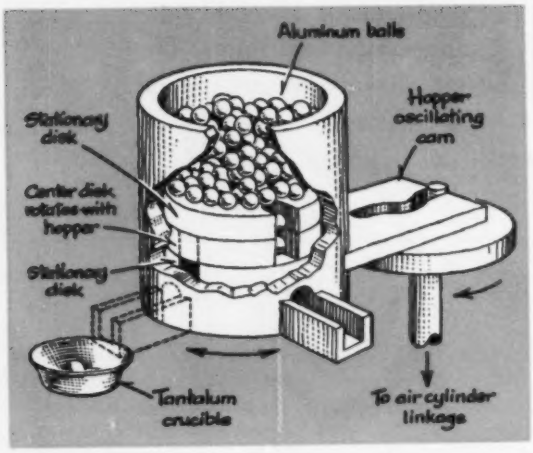


Fig. 3—Charge hopper and feeder is mounted within work chamber. Containing a day's supply of aluminum charges, hopper mechanism feeds single aluminum balls to crucible. One ball contains proper mass of aluminum to plate exposed, downward facing surfaces of crystals in the work holding nest.

angle of the holders and their position relative to the crucible, exposed crystal surfaces are essentially perpendicular to the plating source. The aluminum balls which are fed into the crucible are of pure metal with a mass that will result in the proper plating thickness on each of the downward facing crystal surfaces when complete evaporation of a ball has taken place.

At the end of its stroke which rotates the work and feeds the ball, the air cylinder trips switches which index the rotary wafer switch into the *Melt* phase of induction generator operation. This is the first of two discrete stages in the plating cycle. Power supplied during the *Melt* phase is controlled to obtain puddling without violent bubbling which might cause small amounts of the molten aluminum to sputter out of the crucible. After the charge is melted, separate timers in the induction generator control circuits cause the power input to be stepped up for the *Evaporate* phase, where maximum speed of evaporation is obtained without damage to the tantalum crucible.

Upon completion of evaporation as controlled by a recycling timer, a signal causes the air cylinder to retract. This retraction actuates the hopper feed, causing a second aluminum ball to drop into the crucible, and rotates the work holding masks through 180 degrees, exposing the second, unplated crystal surface to the plating source. The *Melt* and *Evaporate* cycles are then repeated.

Fifteen seconds of cooling time are allowed after the completion of the second plating operation, after which the rotary switch indexes to the *Cycle Complete* stage, admitting air to the vacuum chamber (valves *A* and *B* are closed and valves *C* and *D* are open). The entire work holding nest assembly is then removed from the chamber and a new nest loaded onto the holding fixture.

The hopper arrangement within the vacuum chamber is large enough to contain a day's supply of aluminum charges. The advantage of being able to load the crucible and rotate the work holding masks while the chamber remains under vacuum is critically important to the production rate of crystals since the time to pump down to operating vacuum, approximately 80 seconds, represents about one-third of the total cycle time. To shorten start-up time for the first operation in the morning, controls provide for a *Night Operate* condition which keeps the work chamber under high vacuum overnight. This reduces the time necessary to "outgas" the equipment preparatory to use.

Special acknowledgment is made to Messrs. Rudolph Ostrow, Marvin Marcus, and James Lipp for their work in developing the machine, and to Mr. Abe Mann for his assistance in the preparation of this article.

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are you stuck?

In the past few years AUTOMATION has helped in the solution of hundreds of widely diversified practical problems in making operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available or suitable techniques are known.

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One of the basic phases of automation for machines and processes is in the application of suitable controls. But custom controls, like other custom equipment, may be too costly for a particular application—unless techniques such as the author discusses are applied.

BUILDING-BLOCK CONTROLS

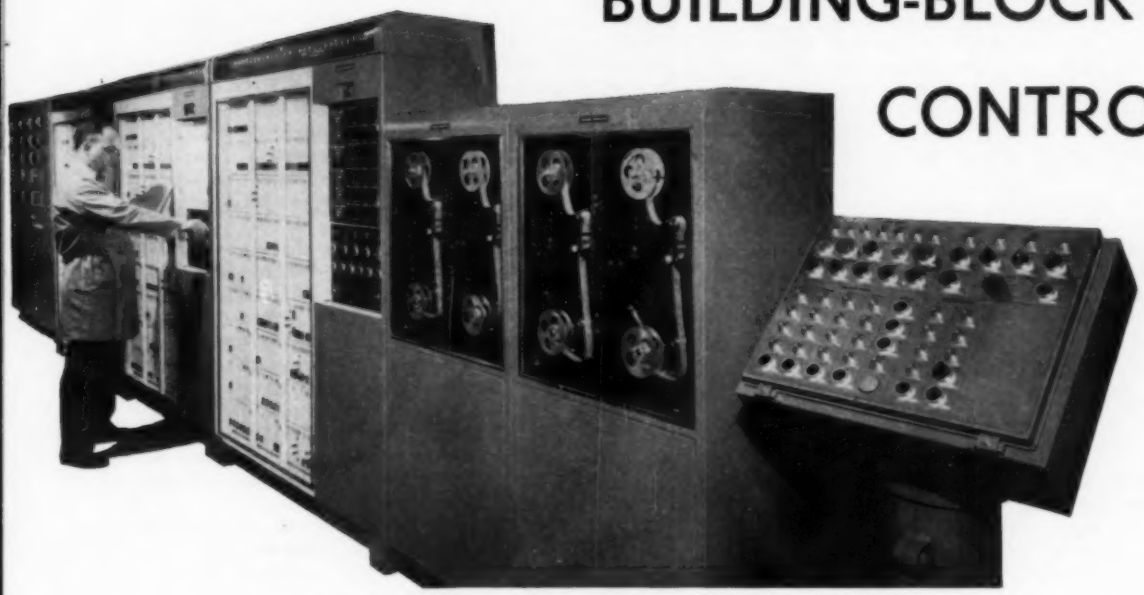


Fig. 1—This control equipment for a numerically controlled transfer line was designed under a building-block concept. It is composed of building blocks determined from functional and equipment viewpoints.

By **W. C. LEONE,** Head of Engineering, Industrial Systems and Controls, Hughes Products, Los Angeles, Calif.

WHAT IS the building-block concept? It has to do with establishing substantially standardized and separable units which may be combined in a number of ways to form integrated systems that will satisfy the requirements of different jobs. This principle is not new. It has been applied in the metalworking industry quite successfully for many years. In the "Detroit type" transfer lines, the extent of standardization and interchangeability for greater flexibility and usefulness is being further increased by the efforts of H. C. Daum and D. C. Pippel of the Ford Motor Co. and committees from General Motors and Chrysler.

When the building-block concept is mentioned with regard to electronic controls, one thinks of modular design. That is, circuits such as flip-flops, *And* gates, *Or* gates, amplifiers, etc., are packaged in plug-in *inserts* and are combined to form a control system. These are indeed building blocks and make possible many benefits of the concept. However, they are *equipment building blocks* and—except for components, such as transistors, diodes, resistors, etc.—are the most elementary units in a control system. The concept can be applied more profoundly by combining various *inserts* in different ways to make *equipment subassemblies*, which make possible a higher level standardization and separation.

However, the breakdown of a system into subassemblies, and of subassemblies into inserts, is not enough. To obtain maximum benefit from application of the building-block concept, the system should also be divided into functional units which can be substantially standardized and separated. This is obtained partially by breakdown of the system into the individual circuits which are packaged in insert form. Additionally, these can be the intermediate

TAPE-CONTROLLED TRANSFER LINE

APPLICATION of the building-block concept has been made by Hughes Aircraft Co. to the controls for an integrated line of machine tools. The line consists of three basic machine tools, an interconnecting conveyor system, and electronic controls.

Coded information, consisting of machine operations and control instructions to the machines, is fed to electronic control units which also receive data from reading mechanisms indicating work and tool positions. From these inputs, the electronic control units derive signals for controlling the power drives to move the work and tools.

The medium used for storing the machine information is a punched paper tape. One tape contains all the operations by all machines in the automatic line on one particular part, and one electronic control unit is associated with each machine in the line. As the parts in the line advance from one machine to the next, the tape readers are also switched to the correct machine control unit.

The input equipment for these machines has been designed so that it may be used to prepare a control tape by entering dimensions, feeds, speeds, etc., from a planning sheet. For most convenience, all operations pertaining to the machining of one part are entered onto a single control tape. The installation has the ability to machine as many types of parts in a single setup as there are provided tape readers. This ability was provided to enable mixed batches of parts to be machined on the line since only one holding fixture for each part has to be fabricated, and it is advantageous to simultaneously manufacture several parts of the same assembly.

The machine tools are special machines, not modifications of standard designs. They employ, as far as possible, a common base design. These bases each have a four-position rotary table, which can be modified later for position control to fractions of a degree. The installation of the machines is such that a worktable, or pallet, can be transferred on a set of ways from machine to machine. The work to be machined is held in a fixture fastened onto the pallet. For each machine, the working spindle can be positioned in three axes with respect to the rotary table.

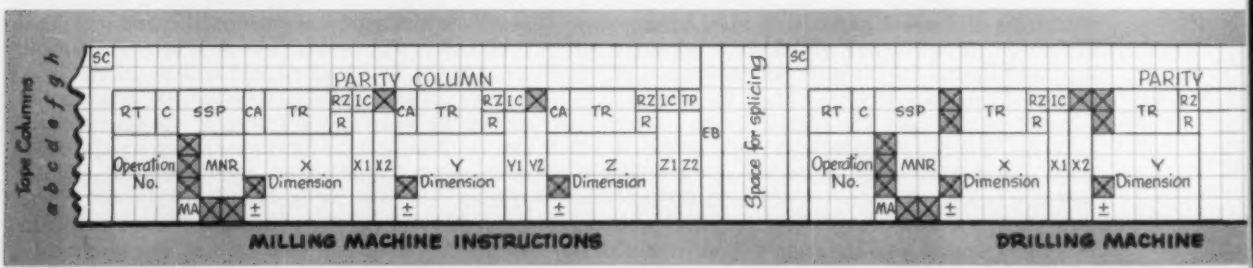
A horizontal milling machine was selected as one of the machines in this first line. In order to obtain high accuracy from the milling machine and minimize the set-up time required when changing the cutting tool, several novel features have been incorporated in the milling machine controls. The first of these is the setting of cutter radius and fore and aft positions of the cutter on dials provided on the machine. The controls will add or subtract this radius or variation of tool position in the cross axis. The planner needs to know only the approximate diameter and position of the tool within ¼ inch. This feature avoids the necessity of grinding cutters to a precise diameter. It also allows the machinist to adjust all the dimensions in a given axis, if a consistent error is found in the finished parts. Another feature is the possibility of correcting a single dimension on a particular part by hand punching a correction in the control paper tape. Space is provided on the tape for two such corrections on each axis.

Many conveniences are provided for the planner, such as the choice of single or multiple axis control to determine whether the machine shall position in the longitudinal, cross, and vertical axes sequentially or simultaneously. It is also possible to retract the machine to the limit position or to a zero reference position. The zero reference position can be set up by the programmer to be any position on any of the three machine slides. It is also possible for the planner to change the reference axis from a zero position on the machine slide to any desired position corresponding to a reference axis on a blueprint if this saves additions and subtractions when making up the control tape.

The second machine selected for the first line is a drilling machine capable of drilling a number of different size holes within a given range. To meet this requirement, the machine has a multiple-spindle head with provision for selecting the proper spindle. Spindle designs incorporate individual lead screws, making it possible to tap with this machine.

KEY TO TAPE LOCATIONS

C- Coolant
CA- Cutter adjustment
D1- First correction for boring diameter
D2- Second correction for boring diameter
EB- End of block (holes in columns *e*, *f* & *h*)
FR- Feed rate
H- Hold
IC- Inhibit creep
M- Move
MA- Multiple axis
MNR- Machine number reference command
PARITY COLUMN- Punched for odd parity
R- Retract to limit switch
RT- Rotary table
RZ- Return to zero
SC- Start code
SSL- Spindle selection
SSP- Spindle speed
TP- Transfer part
TR- Traverse rate
X1- First correction for X dimension
X2- Second correction for X dimension
Y1- First correction for Y dimension
Y2- Second correction for Y dimension
Z1- First correction for Z dimension
Z2- Second correction for Z dimension
⊠ - Spare available hole location



In addition to these operations, the machine is capable of counterboring, countersinking, and end milling within a limited range of cutter sizes.

The third machine in the line is a boring machine with two spindles and provision for programmed adjustment of tool radius. The boring tool can be set in increments of 0.0001 inch so that a high order of accuracy may be expected in hole diameters. Hole centers have accuracies consistent with positioning accuracies of other machines in the line. The spindle motor and gearboxes are designed so that special adapters may be used on either or both spindles for use with milling cutters.

All actions of the machines are under full control of electronic control units which receive coded information from punched paper tapes. The tapes, one for each part, are switched to each machine in sequence. In starting there is one part on the first machine and no parts on the other machines. The paper tape for the first part is connected to the first machine. The paper tape is read one line of eight holes at a time. The dimensions in each block of the tape are read from the perforated tape into a Desired Position Register which is shared by all three dimensions—cross, vertical, and longitudinal. The information on the tape is in binary coded decimal form and is converted into pure binary notation during read-in to the electronic control unit. During the read-in of desired position data, the cutter adjustments and tape modifications are also taken into account.

As a machine slide moves, incremental motion pulses are generated by the magnetic sensing of a steel scale which is attached to the machine slide itself. These incremental motion pulses, one for each 0.0001 inch of motion, are stored in binary form in the Present Position Register, which is also shared among the three axes.

The contents of these two registers are continuously compared and the numerical difference and its sign are used to control the hydraulic motor so that it drives the slide in a direction to reduce the difference to zero. At a predetermined difference between the desired and actual positions, the motors are automatically slowed down to allow accurate final positioning. The Present Position Register and Desired Position Register are actually circulating registers in an acoustic delay line, and the present positions are corrected and compared with the desired positions once each circulation time.

unit—the *functional subsystem* corresponding to the equipment subassembly.

The building-block concept has been applied to the digital controls, *Fig.* 1, for a line of machine tools performing work on castings and flat stock without operator control of individual machines or manual handling between them. More information on the operation of this line is included in the box headed "Tape-Controlled Transfer Line" and also in a previous article on this particular application.*

▶ Functional Building Blocks

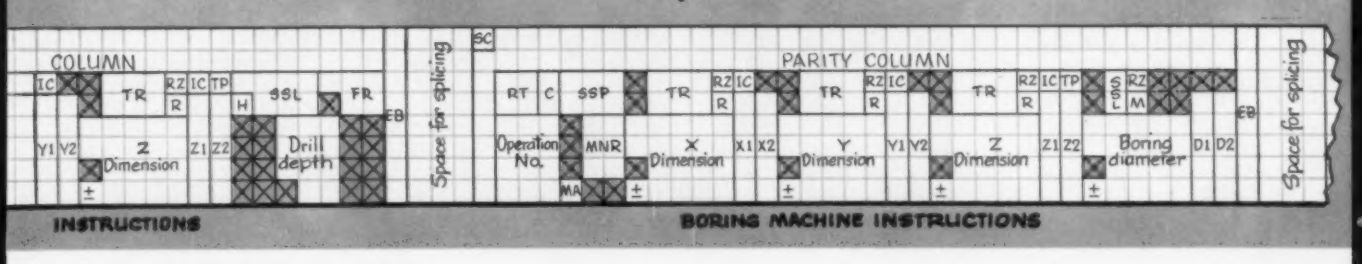
In applying the building-block concept to this integrated line, it can be seen that the first logical breakdown functionally was an electronic control unit for each machine tool. This made possible a line of any number of similar and/or different machines. This breakdown also allows an electronic control unit to serve as both a functional and an equipment block.

Let us consider for a moment the operational functions to be performed by a typical machine in the line. Dimensional information for desired positions of machine slides is available from punched tape and cutter switches. Supplementary information, including auxiliary functions to be performed, is also available from the tape. In addition, dimensional information with respect to present positions of machine slides is available from the position measuring units on the slides. The electronic control unit must receive this information, convert it to a proper form, combine it in appropriate time sequences, and generate signals to control the machine actuating elements.

The functional building blocks that comprise an electronic control unit and which provide these operational functions are the input unit, scale count unit, timing unit, output unit, and auxiliary functions unit, *Fig.* 2.

Input Unit. This unit controls the tape reader and stores the dimensional information from the tape. The desired position information in a tape block, the incremental correction (tape modification), and the cutter allowances from the switches are transformed into binary-coded decimal form. These are combined in the input unit to give a true desired position and converted to binary form. The information is stored in a buffer register until it is transferred to the working register of the out-

*"Tape Controlled Transfer Machine Handles Different Parts Simultaneously," AUTOMATION, Vol. 5, No. 6, June 1958, p. 34.



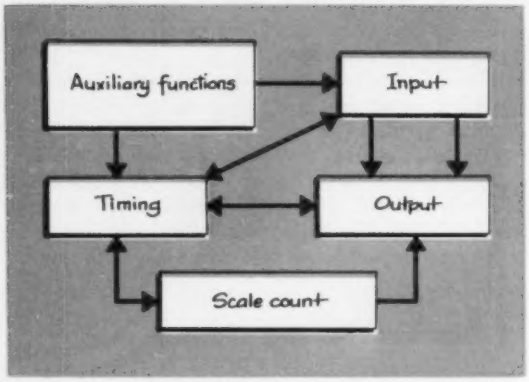


Fig. 2—Basic functional building blocks and their interrelationships are indicated by this sketch. Each machine in the tape-controlled transfer line is provided with an electronic control unit including these functional blocks. Application of these functional units is not limited to machine tools.

put unit upon request, after which a new block of tape is read.

A parity check of all holes in each row of tape and a check on arithmetical operations performed in the decimal to binary conversion are also made in the input unit.

Scale Count Unit. Used in conjunction with three position-measuring units, this unit determines the position of a scale with respect to a measuring head for each of three axes. This is essentially a counter for monitoring the motions along each axis at all times. The movement of one increment on the scale is interpreted as one count. Direction sensitivity of the position measuring device makes it possible for this count to be added or subtracted depending upon the direction of slide movement. Each count is accumulated in a register so that a total in the register represents the present position on that axis relative to a reference point. The information is then sent to the output unit to be used for generation of *Move* signals.

Each scale count unit accommodates as many as three axes. Machines requiring four, five, or six axes of control need two scale count units. That is, a machine with three controlled axes of motion would be equipped with the functional building blocks mentioned (using one scale count unit). Four, five, or six controlled axes of motion would require those units plus an additional scale count unit. A controlled rotary table positioned to angular increments looks no different to the scale count unit than an ordinary linear axis of motion and is treated as such in laying out the building blocks to do the job.

Output Unit. Combining the information from the input unit and scale count unit, the output unit generates signals for moves and supplementary functions. In the output unit, the present position is subtracted from the desired position continuously. The sign of the resulting difference determines the proper direction of travel and causes signals to be sent to the output actuating elements for move, direction, and slow down.

Auxiliary Functions Unit. This unit provides controls and generates signals for spindle speed, traverse rate, index table position, coolant setting, cutter adjustment, etc. These are, incidentally, optional controls which are supplied only if needed.

Timing Unit. Unit provides timing for and coordinates all other units. Information pertaining to present position and desired position is stored serially in circulating registers. It is the function of the timing unit to provide the proper sequence relationships for selecting information from the registers, combining it, and causing signals to be generated.

▶ Equipment Building Blocks

As mentioned before, the next elementary equipment building blocks beyond components such as transistors, diodes, etc., are the flip-flop, gate, amplifier, and similar inserts, *Fig.* 3. The Hughes design also provides intermediate building blocks between the inserts and the whole electronic control

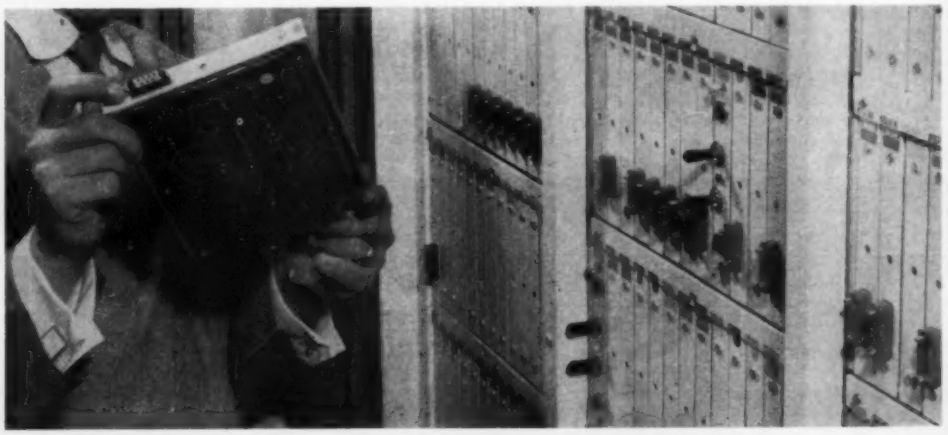


Fig. 3—From an equipment standpoint, controls can be broken down into inserts such as the one being inspected here. These inserts can be combined to form equipment subassemblies that serve as intermediate building blocks for assembly of complete electronic control units.

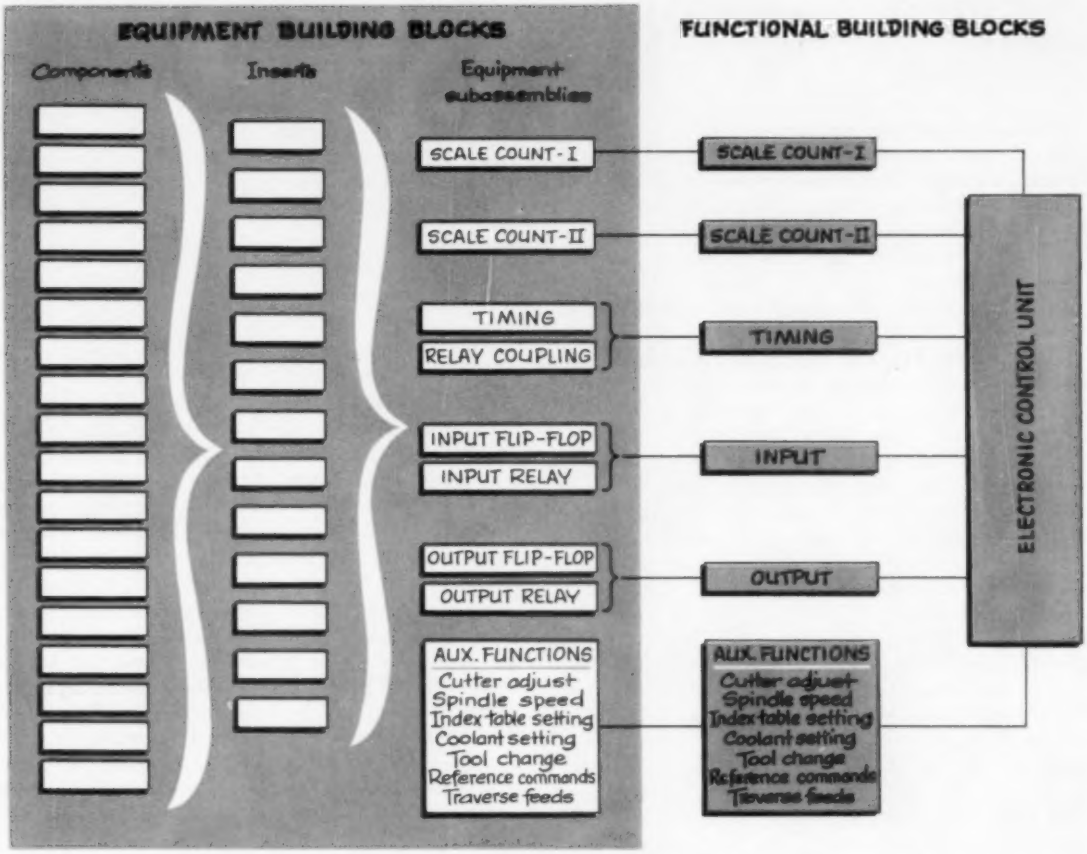


Fig. 4—Functional elements of a control unit may be built from equipment subassemblies following the pattern indicated.

unit. These intermediate blocks (equipment subassemblies) are: Scale count unit I, scale count unit II, timing unit, input flip-flop unit, output flip-flop unit, relay coupling unit, input relay unit, output relay unit, and auxiliary functions unit. These intermediate equipment building blocks are related to the functional building blocks as shown in *Fig.* 4.

The scale count unit is a counter which can be segregated quite easily from other functions and other equipment. All that is required is that the timing for co-ordination of the information be provided from an outside source, the timing unit. The timing unit itself acts as a co-ordinator of all events. It is perhaps the least separable unit both functionally and equipment-wise because of the extent of its activity. The input unit functionally has control and storage type information to deal with; equipment-wise it is convenient to separate these into an input flip-flop unit and an input relay unit. A similar situation exists with the output unit as shown in *Fig.* 4. Finally, the auxiliary functions unit involves, most often, direct storage and output of information for controlling actuating elements and, therefore, is readily segregated equipment-wise into a unit made up largely of relay circuits.

▶ Other Machines and Processes

The great value of the building block technique comes to the fore in considering other machines and processes. It can be seen that the operations performed by the functional building blocks and their equipment counterparts are not restricted to machine tools.

In the particular machine tool application described the scale count unit counts increments of distance traversed by the detector portion of a position measuring unit. This same unit is just as capable of handling increments of other quantities that may be represented by counts when measured by various detectors.

The input unit deals with information fed into it from a tape, converts it to binary form for storage, and eventually transfers it to an output unit. The same kind of punched tape can be, and is, used for many processes other than machine tool work. However, it is important to note that the input unit functions are not restricted to handling information from a punched tape. Dials, switches, keys, cards, and other input sources can be made to operate with the input unit.

The output unit performs some not-too-compli-

cated arithmetic functions and controls the generation of signals to a wide variety of actuating elements. Storage of information and generation of signals to actuating elements is also the case with the auxiliary functions unit. The nature of the arithmetic functions (add and subtract) and the actuating elements is by no means restricted to machine tools for these functional building blocks to be useful.

As a purely fictitious and rather elementary example, it may be desired to develop a control system for a process to produce numbers of 20 items as required by the Sales Department. The item may be such that a single order is for a fixed total number of items, say 500, but the mix is determined on order. Let us assume that a signal to any of 20 actuating elements produces one of the items, and that a sensor beyond each of these actuating elements is capable of automatically determining whether the item produced is good or not. The nature of the production may be such that the yield of good items is not constant for a given input.

The available input may be information from the Sales Department with respect to orders for each of the 20 items and various requirements on them such as paint or other markings. A control system to satisfy these requirements will have to accept and read the Sales Department input information and convert it to a usable form. The desired number of each of the 20 items and supplementary information such as the desired paint may be inserted into switches or put onto punched cards. The control system would then consist of an input unit, 7 scale count units, an output unit, an auxiliary functions unit, and a timing unit. The input unit would take the signals from the switches or card reader contacts and convert it to a usable form. Properly timed signals to the output unit and auxiliary functions unit would cause the actuating elements to produce and paint parts. The scale count units would accumulate counts of usable items so that as long as the difference between the programmed number and the number in the scale count unit for each item is other than zero, the corresponding actuating element is producing that item.

It can be seen that the building blocks discussed here do not impose great limitations on the nature of the process. In a machine tool system, distance is the chief process variable; in the fictitious example, number of good items—ones that pass inspection—is the variable. The process variable can be a weight, a volume, a rate, or anything for which a sensing element is available, or can be made, and that is amenable to a counting technique.

▶ Advantages

The advantages of a judicial breakdown of a system into equipment and functional building blocks affect many factors.

Lead Time: Since the building blocks are standard, a new system does not require a completely new engineering design. Rather, a system engineering job is required for building an aggregate whole from the available subsystems. The lead time in accomplishing the integrated system is certainly less than that required in starting completely anew.

Maintenance: Field maintenance is much easier when both operational units and equipment units are segregated. This breakdown allows for maintenance to be symptomatic rather than diagnostic. Test equipment can be built to more readily locate the function, and therefore, the subassembly that is the source of difficulty. The modular construction makes possible simple replacement of a faulty insert which is sent to the factory for diagnosis and repair.

Reliability and Cost: Utilization of standardized units in various systems means larger production of those units. Therefore, there is greater opportunity for developing more reliable building blocks. This larger production should also lead to reduced cost of the complete systems.

Changes: Obsolescence of equipments utilizing this concept is precluded by the fact that in overhauling of the systems, improved techniques may be incorporated in some of the building blocks or additions made to integrated systems more readily.

The building block approach provides flexibility in designing new systems with proved techniques and equipments. Units such as the ones discussed here and others under development will make possible the desirable goal of customized systems made up almost entirely of building blocks off the shelf.

abrasive wheel prevents ink smudging

ABRASIVE wheels have solved many unusual problems in industry, but one of the most unique is an application at Addressograph-Multigraph Corp. One of the firm's products is a printing machine that converts a roll of blank paper to individually printed and addressed bills for businesses such as insurance and utility companies. At one point in the machine a roller was needed to provide positive paper feed without smudging freshly applied ink.

A small grinding wheel supplied by Norton Co. was tried as a feed roll and worked so well that it became a standard part for the machine. The many sharp particles of abrasive on the surface of the wheel advanced the paper without slippage. Since there was no relative motion between the ink and roller, the ink was not smudged.

Fig. 1—As an aid to manufacturers employing magnetic tape controlled machine tools, an Air Force sponsored center has been established to take punched paper tape prepared by the part manufacturer at his plant (left) and convert it to magnetic tape (right). Serial information on punched tape describes the part to be produced but is not in suitable form to co-ordinate complex motions required in such operations as contour milling.

CO-OPERATIVE DIRECTOR CENTER FOR TAPE CONTROL USERS

WHAT may prove to be a pattern-making co-operative venture in numerical machine control has been established under Air Force sponsorship throughout the west coast area. Basically, this new venture consists of a centralized facility for producing magnetic control tapes for a group of co-operating companies. A similar program inaugurated by civilian users of numerically controlled machines could divide certain high costs between concerns co-operating in such a program.

In this particular Air Force-sponsored program, Convair Div., General Dynamics Corp. has been chosen to operate the centralized magnetic tape preparation facility for the benefit of the west coast divisions of Douglas, Lockheed, North American, Rohr, and other companies using magnetic tape controlled machines on military contracts.

After any associated company (or Convair itself) designs an aircraft or missile part which they desire to be produced on a magnetic tape controlled machine, the initial operation is preparation of a punched paper tape which will eventually be fed into the director unit at the central facility. Preparation of this punched paper tape is the duty of each co-operating company so that when the punched tape reaches the central processing facility, it is only necessary to put it through the director unit.

The first step in making a punched paper tape is to prepare the equations that establish the geometry of the part to be machined. These equations, in shorthand manuscript form, are then fed into a digital computer (IBM 704). The computer, using subroutines, refines the data, creates additional information that details points along desired slopes of lines and segments of curves, and produces the program on IBM cards. The cards are then fed into an off-line unit which reads the cards and types a second manuscript.

An operator, using the second program manuscript, works at a Flexowriter, producing the paper tape with its punched and coded holes. The control information, as it appears on the punched tape, is

in serial form. Thus if the paper tape in this form were used for machine control, the machine would receive related commands sequentially and it would be difficult to obtain the exact co-ordination of complex machine movements and speeds that would produce a true slope or true curve. To obtain proper co-ordination of machine movements, the serial information on the punched paper tape is transposed into parallel information across the width of a magnetic tape so that the machine will receive all the parameters of a single command at one time to produce the co-ordination of movements necessary to machine a slope, a curve, or a three-dimensional form at high feed rates.

As the punched paper tape feeds through the director unit, the serial parameters in each command group are "memorized" by the director unit until all of them have been given. The director unit then records all parameters at one time in a straight line across the 1-inch wide magnetic tape. The magnetic recording head used with the director unit is equipped with 14 separate recording units allowing up to 14 channels of information to be recorded on the tape.

Magnetic tape feeds through the director unit at a speed of 80 fpm, and the speed of the punched paper input tape is so adjusted that a command group is given to the director unit while 0.10 inch of tape is passing the recording head. Thus, 10 linear command groups of up to 14 parameters each are recorded on an inch of magnetic tape, which amounts to approximately 160 groups of commands each second when the tape is played back at the recording speed. At normal machining or milling speeds, 160 commands a second are sufficient to co-ordinate all cutting head movements and will keep the machine operating within a tolerance limited only by its own mechanical abilities.

The 14 channels may contain any information needed to mill a part. Three channels might be used to control the cutting head through the three axes of movement required to mill a three-dimensional part. Other channels might be used for commands controlling such factors as table tilt or rotation; to turn the coolant on or off; to start or stop the machine, or for information regarding types of tools to use, tool sizes, tool grinding requirements and configurations, and similar information. Of course, the amount of information which can be usefully recorded on the tape is limited by the ability of the tape controlled machine on which the tape will be used.

In the co-operative venture utilizing a central facility for the preparation of the master numerical control tapes, each co-operating company will pay only what it costs to have its punched paper tape program transferred to the magnetic control tape. How the various costs might be prorated in a co-operative civilian program to obtain the same results is a matter of conjecture. But it is quite obvious that prorating the initial investment in a director unit would result in a substantial savings for each co-operating company—enough to make such a program very attractive to present users and potential users of numerically controlled machine tools.

MULTISTATION INDEXING MACHINE ASSEMBLES ARMATURE CORES

ARMATURE core assemblies for automotive heater motors are assembled automatically at the rate of 900 per hour on an eight-station indexing machine, *Fig.* 1, designed and built by Cimco Engineering Co. Four separate hydraulic power units are used with the machine, which can assemble cores, *Fig.* 2, having a variety of stacked heights of laminations and shaft lengths. With minor tooling changes, shafts having different diameters may also be run. One attendant services the feed units.

In operation, a parts feeder at Station 1 orients and feeds a shaft bushing into position under a vertical, pneumatically-operated ram. The ram transfers the bushing into a fixture mounted on the indexing table.

At Station 2, coiled fiber insulating strip is drawn from a reel and blanked into laminations by a three-stage progressive die. Scrap from this operation is discharged to a chute and the lamination is placed in the fixture.

Steel laminations are taken from one of three magazines at Station 3 in stacks of the proper height as determined by detectors. The detectors will stop the machine if the proper quantities of laminations are not maintained. When a stack has been released, a shuttle arm carries it over the fixture where it is pressed down over fixture burnishing pins by a hydraulic ram. Adjustments permit setting of the stack height from ½ to 2 inches within one lamination thickness (0.050 inch).

At Station 4, insulating laminations are produced as in Station 2 and placed on top of the stacks of steel laminations in the fixtures.

Shafts fed horizontally from a magazine at Station 5 are positioned vertically over the center of the fixture by a pivoted shuttle arm. A hydraulically-operated ram on an upper platen applies force to the lamination stack while another ram forces the shaft through the stack to the proper position. Interchangeable stops permit varying the distances that

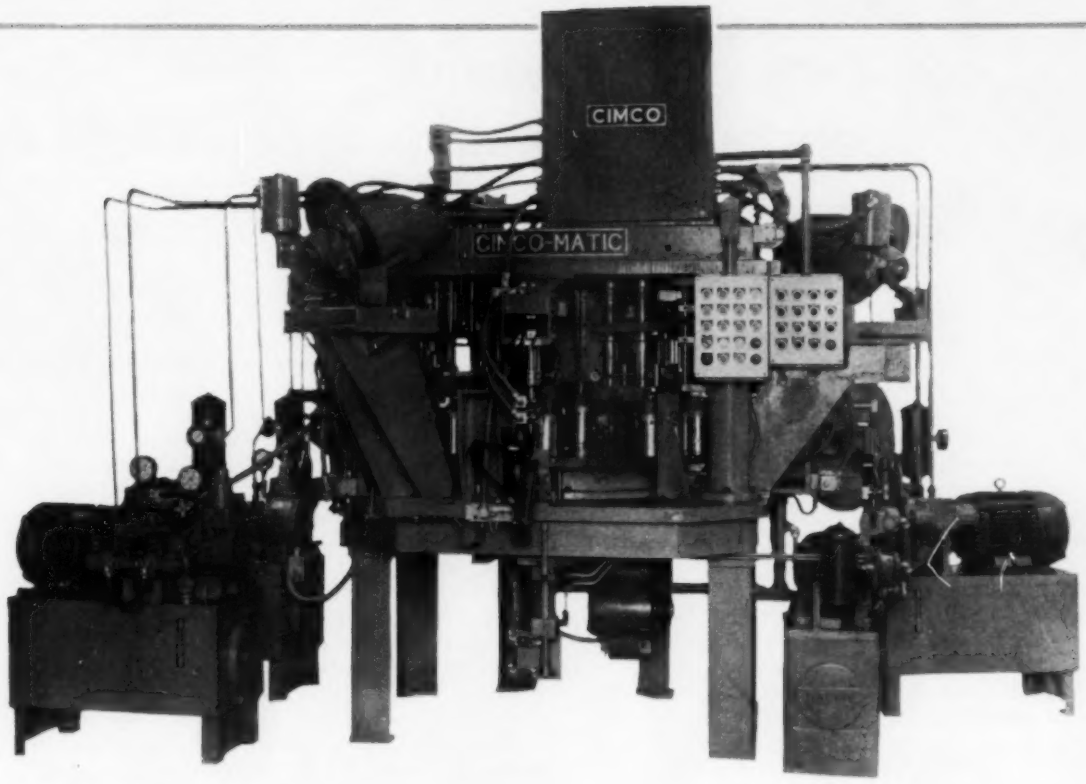


Fig. 1—Eight-station indexing machine automatically assembles armature cores at a rate of 900 per hour. Progressive dies placed at two of the stations fabricate insulating washers from coiled strip. Other components are fed by hoppers and magazines.

shafts can be inserted, as when handling different length shafts.

A second shaft bushing is oriented and fed by a parts feeder at Station 6, and is positioned under a pneumatic ram. The ram assembles the bushing over the shaft in the fixture.

Completed armature cores are lifted off the burnishing pins by a hydraulic cylinder mounted under the indexing table at Station 7. A rotatable arm receives the cores, lifts them, and places them in a horizontal position on two transfer rails. The transfer rails remove the parts from the machine.

At Station 8, probes electrically check for an empty fixture condition. All of the stations are equipped with interlocks that prevent indexing of the table in the event of their malfunctioning and failure to return to a clear position.

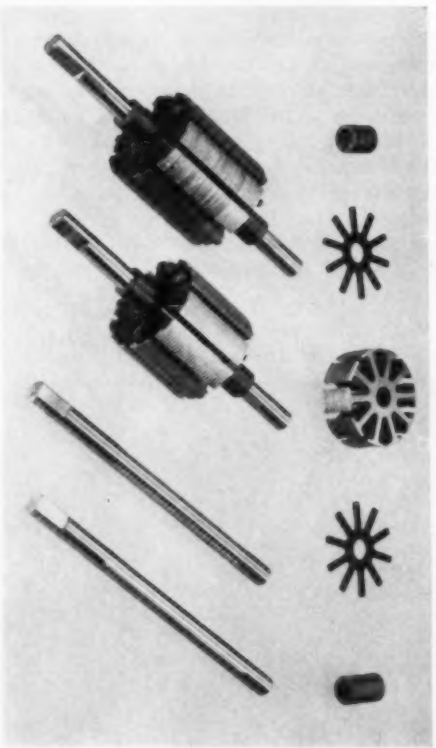


Fig. 2—Two completed armature core assemblies are shown with piece parts used in their assembly. Steel lamination stack heights are different for each of the assemblies shown.

CONVEYOR SYSTEM PERMITS CONTINUOUS RADIATION PROCESSING

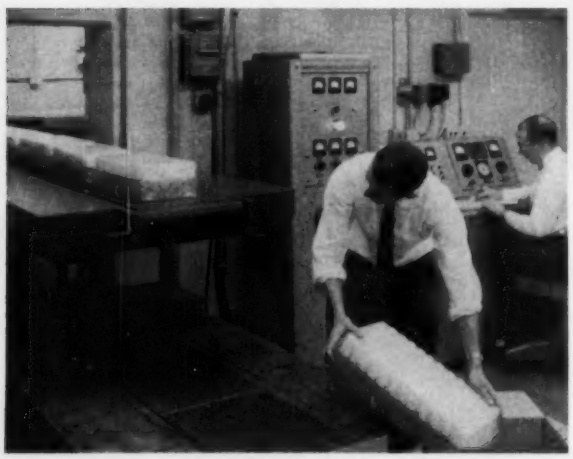
ELECTRON-BEAM RADIATION is providing the means of creating valuable new products and useful new process at the Burlington plant of High Voltage Engineering Corp. Although in its infancy now, irradiation could revolutionize the processing, packaging, transportation, and storage of foods. By causing the death of bacteria, radiation could reduce the need for heat to sterilize food and minimize the need for refrigeration in transport and storage. In the chemical field, irradiation can be used to produce changes in materials. For instance, polyethylene plastics melt at about 222F. However, when they are subjected to high voltage radiation, the plastic material changes its basic structure and becomes tough enough to stand much higher temperatures. The plastic can be sterilized by steam, and its use can be extended to the packaging of drugs and food.

However, since radiation processing is accomplished with either a high velocity electron beam or x-rays, its use is hazardous to humans, and it must be done in a shielded room. High Voltage Engineering uses a 2-million-electron-volt Van de Graaff electron accelerator for its radiation source and encloses it in an L-shaped shielded room. An automatic handling system manufactured by Conveyor Specialty Co. moves materials to be irradiated into the L-shaped room, under the beam of the electron accelerator, and back out of the room. Trays containing materials to be processed are loaded onto conveyor belts outside of the radiation room, pass under the electron source at 18.3 inches per minute, and then are conveyed out of the room for unloading.

Under normal operating conditions, a radiation dose of 2×10^6 rad per minute is given to the material in the processing tray under the electron beam. The processing rate is 3.3 pounds per megarad per minute, or 200 pounds per megarad per hour. Irregularly shaped samples can be irradiated in trays providing the thickness limitations are not exceeded. Products as long as 5 feet can be handled by the system, although not on a continuous basis.

The handling system is made up of standard conveyor building block units. The section under the electron beam is stainless steel with a stainless steel belt and is fitted with time switches so material in process may be carried back and forth under the beam as many times as necessary to receive the radiation desired.

The control system for the Van de Graaff unit is located outside the L-shaped room so that operating personnel are not exposed to radiation. A set of mirrors allows the operator to see the material as it passes through the radiation area. Operating personnel can safely enter the radiation area as soon as the accelerator is turned off. This expedites changes in setups, installation of experimental apparatus, and handling of products not suited to the conveyor system. The equipment can be converted in a few minutes to deliver x-rays, and it is possible to perform experiments with both electrons and x-rays in the same day.



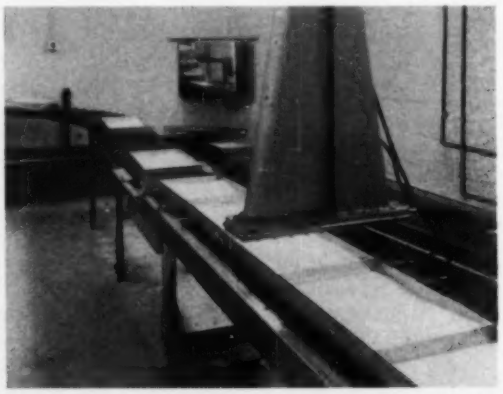
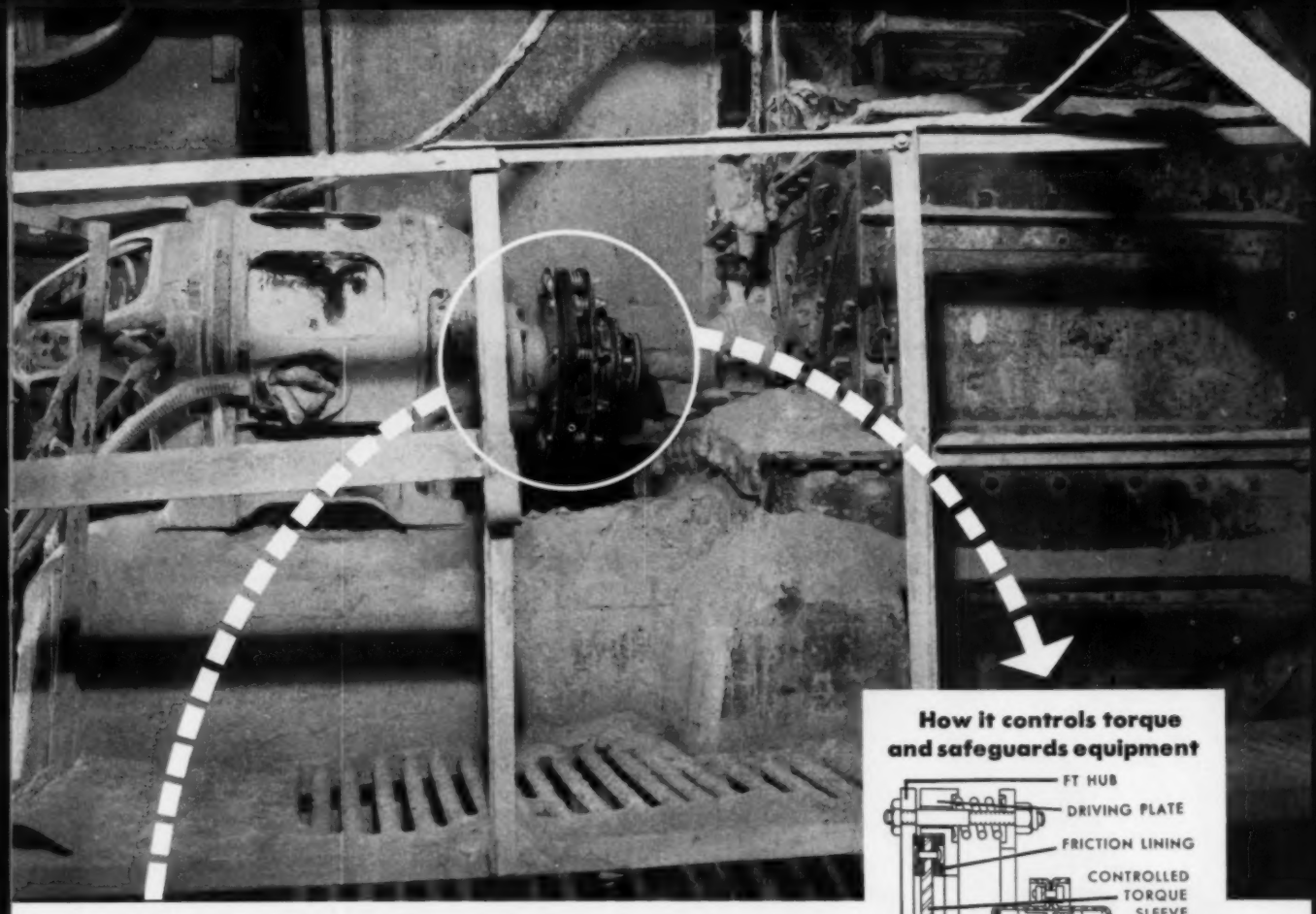
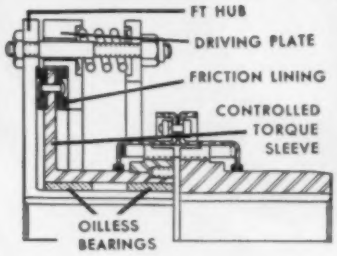


Fig. 1—Plastic pharmaceutical materials requiring sterilization are loaded onto an upper conveyor for transport into the radiation room. Inside the room the plastic materials pass under the beam of the Van de Graaff electron accelerator where sterilization is accomplished. The conveyor then makes a U-turn and carries the materials out of the room for unloading. Mirrors inside the room permit the operator to observe passage of the containers at all times. Controls for the high voltage accelerator are located adjacent to the conveyor loading-unloading point outside the room.



How it controls torque and safeguards equipment



Protect machines from overload damage with FALK Controlled Torque Couplings

The above picture shows a Falk Controlled Torque Coupling connecting a 150 hp motor to a hammermill. Formerly, when tramp iron got into the mill, it was necessary to rewind the motor at least twice a year. But, in the 2½ years after installing a Falk Controlled Torque Coupling, no motor repairs were required. *That is real saving!*

Wherever overload danger exists, a Falk Controlled Torque Coupling gives positive protection against machinery damage from excessive torque or jams. This unique coupling has an adjustable friction slip clutch which can be set at *any* predetermined torque limit. Thus, transmission of dangerous shocks is prevented...overloads are limited...shaft breakage is eliminated.

Another big advantage is that, when the cause of the overload is removed, the entire coupling will rotate and transmit power without resetting, and *without replacing parts or repairing the coupling*....And, the Controlled Torque Coupling incorporates the famous Falk Steelflex torsional resilience to smother ordinary shock and vibration, plus the ability to accommodate shaft misalignment....Consult your Falk Representative or Authorized Falk Distributor. **Ask for Bulletin 4100.**

Here (as in photo), the torque-control hub is shown mounted on driving shaft. From this hub, power is transmitted through friction lining to controlled torque sleeve. Load to be transmitted is determined by the (pre-set) pressure on friction lining. In case of overload, this hub still rotates until power is shut off—but the rest of the coupling and the driven machine will slow down or stop.

Motor Shut-off Control

By adding an automatic cut-out switch with V-belt connection to driven shaft, motor can be stopped immediately. With the standard hub mounted on driven shaft, the switch opens the electric circuit when speed of switch falls below predetermined value.

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Circle 678 on Page 155

New amplifier battles "noise"

Four-stage junction diode amplifier was developed at Bell Telephone Laboratories by Rudolf Engelbrecht for military applications. Operates on the "varactor" principle, utilizing the variable capacitance of diodes. With 400-mc. signal, the gain is 10 db. over the 100-mc. band.

The tremendous possibilities of semiconductor science are again illustrated by a recent development from Bell Telephone Laboratories. The development began with research which Bell Laboratories scientists were conducting for the U. S. Army Signal Corps. The objective was to reduce the "noise" in UHF and microwave receivers and thus increase their ability to pick up weak signals.

The scientists attacked the problem by conducting a thorough study of the capabilities of semiconductor junction diodes. These studies led to the conclusion that junction diodes could be made to amplify efficiently at UHF and microwave frequencies. This was something that had never been done before. The theory indicated that such an amplifier would be exceptionally free of noise.

At Bell Laboratories, development engineers proved the point by developing a new kind of amplifier in which the active elements are junction diodes. As predicted, it is extremely low in noise and efficiently amplifies over a wide band of frequencies.

The new amplifier is now being developed for U. S. Army Ordnance radar equipment. But it has numerous other possibilities. In radio astronomy, for example, it could be used to detect weaker signals from outer space. In telephony, it offers a way to increase the distance between relay stations in line-of-sight or over-the-horizon communications.

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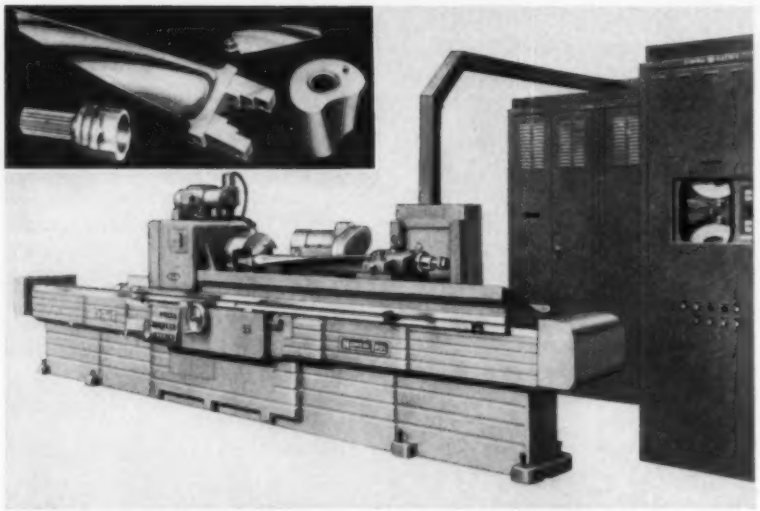


Numerically Controlled Profiling Machine

A NEW development in profiling machines designed by **Ex-Cell-O Corp.**, 1200 Oakman Blvd., Detroit 32, Mich., employs numerical control to guide machining around the axes of workpieces. These tape controlled machines are economical in producing prototypes, small lots of parts that are difficult to machine without special tooling, and cams and templates for standard production machines. Ex-Cell-O Corp. designs and builds only the machines; it does not manufacture the control equipment. The machine is available with two types of numerical control systems. One is operated by a magnetic tape system and electro servo motors, can produce steam turbine buckets in small lots. The second system uses punched tape and hydraulic servo motors, can produce cams, templates, and prototype jet engine blades.

All instructions for the machining operations are recorded on tape. The length of time required to make the tape depends on the complexity of the part. Operation of the machine is simple. After the tape is inserted and the workpiece loaded, the machine is set at *Zero* position and the cycle starts. Besides being equipped for milling operations, the machine can be used for grinding, and incorporates wheel dressing and dressing compensation.

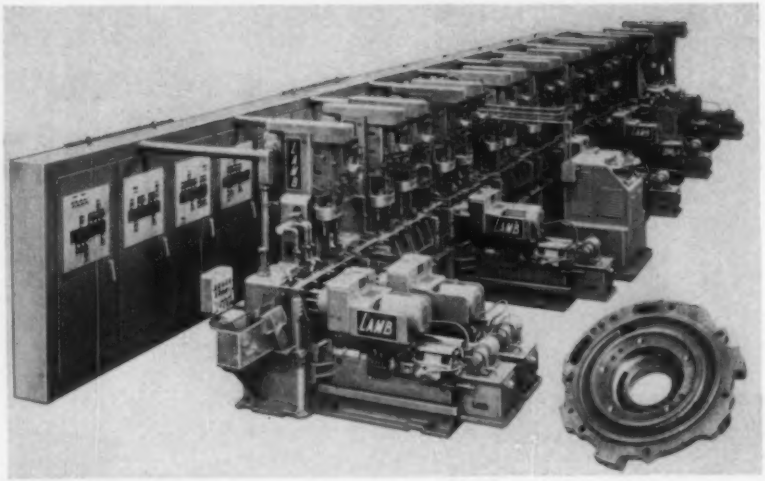
Construction Features

The cast base has a concrete foundation, is ribbed for rigidity. Leveling pads and jack screws provide means for leveling and alignment. The work table and cross slide are actuated by preloaded antifriction lead screw and nut assemblies. These assemblies decrease backlash and permit accurately controlled table movements with a minimum of power. The work table casting moves on V and flat ways, on hardened and ground rollers in retainers. A pull of 14 pounds will keep the table in motion; it can be moved with a breakaway force of only 18 pounds. The milling and grinding assemblies are interchangeable. Milling unit consists of a spindle, a gear reduction motor, and a silent chain drive. Grinding assembly consists of a grinding spindle with its drive equipment and a hydraulically operated swivel type diamond dresser. The spindle is mounted on a small slide that provides movement in an axial direction. An elongated cup-type grinding wheel is dressed to a spherical shape of a definite radius and this is maintained throughout the life of the wheel. The position of the grinding wheel in relation to the work is always maintained regardless of the dressing operation. This is accomplished because the wheel spindle moves toward the stationary dresser, giving the operation the effect of an automatic sizing device. A pause in the machining cycle, the withdrawal of the cross slide for the dressing operation, and the frequency of dressing, are controlled by tape.

The work is held either between centers or in some type of work holding device. During grinding and in rotary milling operations one motor drives the work spindle and, through a train of gears, also drives the lead screw to give the necessary feed per revolution. An alternate method is longitudinal milling whereby the work feeds lengthwise in relation to the mill-

ing cutter then indexes and feeds back. With this method, feeding and indexing continue until the work has been rotated 360 degrees. A second motor drives the lead screw, and at the end of each stroke the first motor indexes the work spindle.

Circle 401 on Page 155



Machine Produces Automotive Pump Bodies

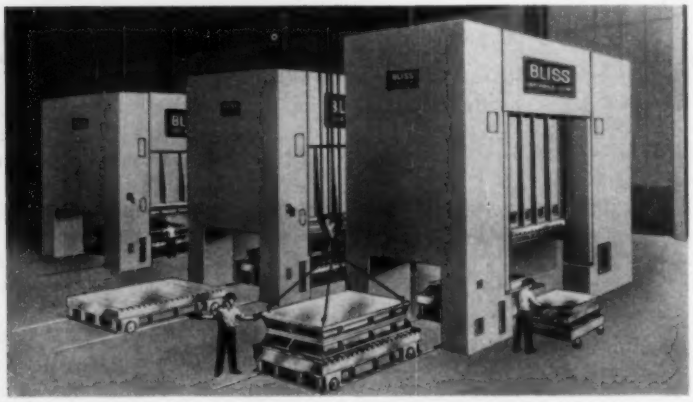
Item 402

Thirty-one station transfer machine is capable of producing automatic transmission pump bodies at the rate of 378 per hour. It machines the part from five different angles and three positions. The machine is designed on the "building-block" principle, features simple subunit rearrangement for production flexibility. The main base is a series of welded steel units each of which has machined mounting faces for supporting fixtures and accessories and for attaching wing and column base units. Each station is thus a self-sufficient machine.

The stations which perform the milling, drilling, and tapping operations are supported by wing units which are horizontally mounted on the right sides of the bases, providing access on the left sides of the bases for fixtures, tools, and clamping mechanisms. The transfer mechanism is the walking beam type with hardened part nests. Removable probes can be replaced easily by lifting a retainer plate and sliding the probes out of their bushings. Only one limit switch is needed for the probes.

Other features of the machine are: An automatic centralized lubrication system, individual control buttons at all working stations, a master electrical pushbutton control at the load station, and separate chip coolant chutes in each base block. Panel-mounted signal lamps identify malfunctions. **F. Jos. Lamb Co.**, 5663 E. Nine Mile Rd., Detroit 34, Mich.

Circle 402 on Page 155



Automatic Devices Speed Die Changeover

Item 403

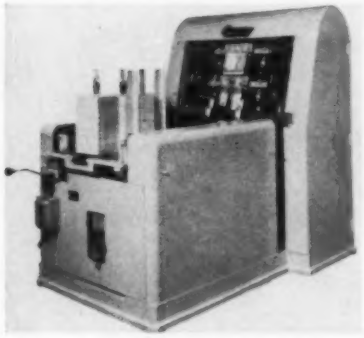
Three attachments for presses are designed to reduce die changeover time. The units are: A moving boltster plate, an automatic die clamping device, and an automatic slide positioning device. The moving bolster assembly has its own pressure pins and a pressure pin plate to keep the pressure pins in place while the bolster is being moved into or out of the press. Each bolster assembly is individually controlled by a master control panel. The bolster travels on special tracks to a lowering mechanism built into the press bed. This mechanism lowers and accurately positions the bolster assembly in the press. While one die is in use stamping out parts, another die can be secured to the bolster which is outside of the press. At the time of die change, the bolster in the press is rolled out, and the other bolster is rolled into position.

In die changeover, the press slide is brought to the bottom of its stroke so the unwanted punch is nested into its companion lower die. An *Unclamp* button is pushed, initiating an automatic sequence of operations for unclamping the punch from the slide. The press slide is then run up by an adjusting mechanism to clear the top of the punch, and the old bolster and complete die set are rolled out of the press. The other bolster with the new die attached is run into the press, and the slide adjusted to position. A *Clamp* button is pushed, starting a clamping cycle. When the punch is securely locked to the press slide, an indicating light turns from red to green. The die clamping device is available in two different sizes, the type depending on

the size of the press.

The die shutheight in the automatic slide positioning device is preselected by a dial in the master pushbutton panel. When the slide adjustment is actuated, the slide will automatically position itself at the predetermined shutheight. In operation, the slide adjusts at a rapid traverse rate until it approaches the die. When a predetermined distance above the die is reached, it automatically changes to a slow speed which positions the slide to within 0.002-inch of the preselected die height setting. **E. W. Bliss Co.**, 1375 Raff Rd., S. W., Canton, Ohio.

Circle 403 on Page 155



Package Former

Item 404

Machine produces cartons and trays for packaging cookies, crackers, confections, frozen foods, vegetables, cosmetics, and cigarettes. The cartons and trays are formed from poly-coated blanks and are heat sealed. Material provides high resistance to grease and moisture. Model SG-P operates at a rate of 180 forms per minute. When there is no need for protection against grease and moisture, the machine forms and glues cartons from non-coated blanks. **Peters Machinery Co.**, 4700 N. Ravenswood Ave., Chicago 40, Ill.

Circle 404 on Page 155

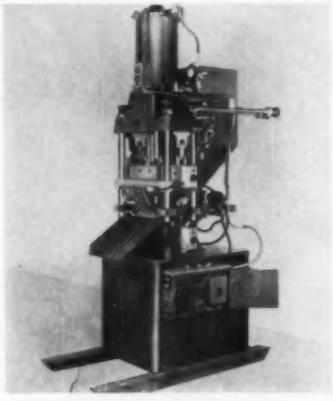
Roller Conveyor Kit

Item 405

Packaged conveyor kit consists of a series of sections which can be assembled with a wrench to meet individual requirements. Straight sections are in 5 and 10-foot lengths; widths are 12, 16, 20, and 24 inches.

To assemble, the frames are bolted together and the rollers sprung in place. The rollers become high or low in the frame by turning the section over. Supports give an adjustable height from 40 to 46 inches when rollers are high, and 38 to 44 inches when rollers are low. The supports clip in place, can be located at any position along the side rail. Slope for gravity movement of loads is readily provided. **Mechanical Handling Systems Inc.**, 4600 Nancy Ave., Detroit 12, Mich.

Circle 405 on Page 155

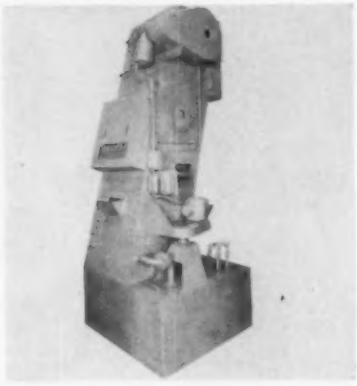


Plastic Molding Press

Item 406

High speed, air-toggle powered automatic plastic molding press is suitable for thermosetting materials and alkyds. Molds can be changed in less than 2 hours. Press can be used to provide a variety of items for the automobile, appliance, and electrical field. It is available in two styles (Model A50-B and Model A25-B), which operate on air at 100 psi. Depending on the model, press provides a maximum of 25 or 50 tons pressure. The machine is a top ejection type. When single-row cavity molds are employed, molded parts are mechanically ejected; molded parts from multiple-row molds are air-ejected. **Automatic Molding Machine Co., subsidiary Wagner Bros. Inc.**, 3201 Exposition Place, Los Angeles, Calif.

Circle 406 on Page 155

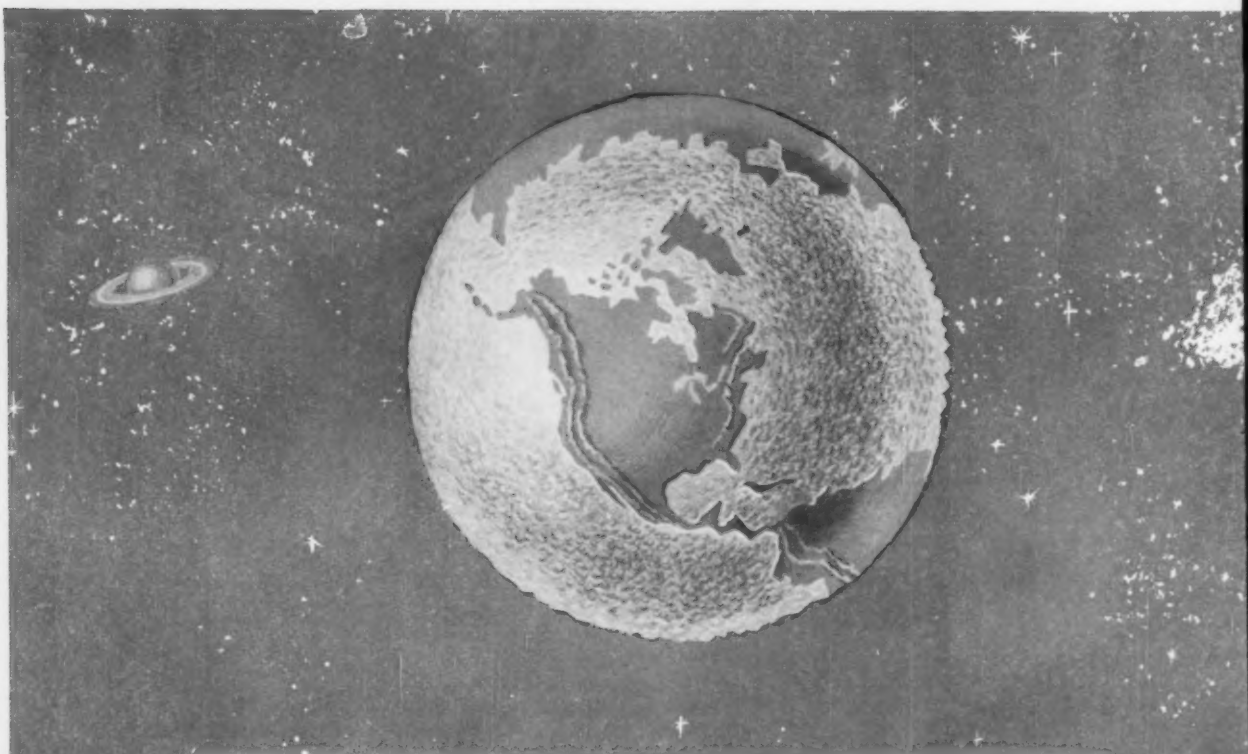


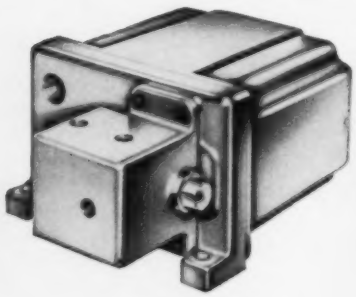
Continuous Washer

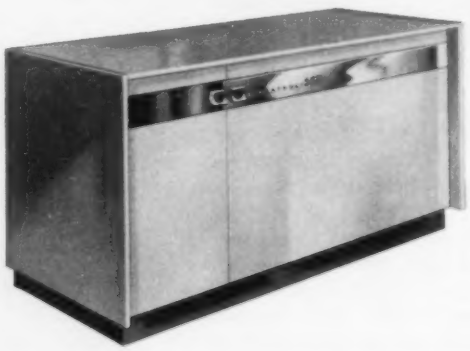
Item 407

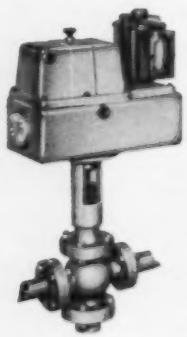
Unit is presently in use for washing wrench jaws after a broaching operation at the rate of 2000 pieces per hour. Machine is a vertical design, occupies only 16 square feet of floor space. In operation, work is handled by a separate loading conveyor which carries it to a charging hopper. From the hopper, parts proceed to a series of perforated flights attached to a double chain conveyor. As the flights travel upward, the parts are thoroughly cleaned through a spray action. The solution is applied to the parts by means of a packless centrifugal pump. The solution tank, which is located in the base of the machine, is heated by removable steam plate coils. After the spraying action, the solution returns through the machine housing to the tank for recirculation. The flights continue upward and are inverted when passing over the head sprocket, automatically discharging the work into an unloading chute. After the work is unloaded, the perforated flights travel downward to the tail sprocket returning to the *Start* position. Operation is continuous. **Ransohoff Inc.**, N. Fifth Street and Ford Boulevard, Hamilton, Ohio.

Circle 407 on Page 155









Above, left—The GPE Controls Electric Flow Transmitter, a completely new idea in flow signal transmission. Completely transistorized, without complex mechanics, it transmits a high-level signal proportional either to flow or to differential pressure. Precise measurement and signal transmission are first in importance in good control.

Above—The Libratrol-500 Process Control System, made by Librascope and available to industry through GPE Controls, Inc., is developed around this highly reliable, rapid-response digital computer. It provides for a full range of process control—from accurate processing of data to provide understandable information to a human operator, to complete automatic control of an entire process or group of interrelated processes.

Left—One of many GPE Controls Electrohydraulic Valve Actuators that combine the speed and positive action of hydraulic valve operation with the flexibility of electrical control and signal transmission.

In the world of

INDUSTRIAL PROCESS CONTROLS...

tomorrow is already here!

What do you expect of tomorrow's automatic control systems? If you are looking forward to the advantages of computerized control systems . . . greater reliability in signal transmission . . . further localization of the control function, with centralized supervision . . . better response of final control elements . . . then for you tomorrow is already here.

GPE CONTROLS, Inc. brings to industry computer controls, components, and greater understanding of system dynamics – offered by several subsidiary companies of General Precision Equipment Corporation: *Librascope* for digital data-logging and closed-loop computer systems and associated components; *Kearfott* for high-performance hydraulic components and controls; *Link Aviation* for analog computer controls, product service, and manufacturing capabilities; *Askania* for more than 25 years of dealing with the control problems of industry.

GPE CONTROLS, Inc. welds together all these industrial control capabilities and makes them directly – and immediately – available to you.

Why not see what the engineers of GPE Controls can do for you? You'll be seeing this nameplate on the most exacting control-computer installations – soon and often.

GPE Controls inc.

(Formerly ASKANIA REGULATOR COMPANY)

Executive Offices and Midwest Regional Headquarters
240 East Ontario Street, Chicago 11, Illinois

Eastern Regional Headquarters and Hydraulics Division
1500 Main Avenue, Clifton, New Jersey

Western Regional Headquarters
40 East Verdugo, Burbank, California

GPE Controls — GENERAL PRECISION EQUIPMENT CORPORATION

. . . serving industry through coordinated precision technology

Circle 679 on Page 155

Western Electric Gets Plantwide Savings...

Work is handled in aluminum trays, routed through rebuilding operations by means of pre-set pin deflectors. This conveying system incorporates A-F Live Roller, Gravity Roller, Belt and Truck Towing Conveyors.

with its

A-F PLANTWIDE Conveying System

ABOVE — Portion of order picking operation. Hampers in which orders are collected stop only at stations where pickup is to be made. Turntable in foreground provides 180° turn in 25% less space than conventional curve.

In keeping with its reputation for efficiency, the Western Electric Company requested us to install a completely co-ordinated conveying system throughout its new Solon, Ohio, distributing house for rebuilding and storing telephone equipment. Now, individual jobs are routed quickly and automatically from operation to operation, by-passing unnecessary work stations.

In the warehouse, too, this completely co-ordinated, plant-wide conveying system speeds order picking, saves countless steps and money!

Whatever *your* product handling problem, A-F can help you engineer a conveying system that will *cut your costs—make money for you.* Write us—without obligation —today.

YOU CAN SEE THE SUPERIORITY OF A-F CONVEYOR ENGINEERING

A-F

A-F *ENGINEERED* CONVEYING SYSTEMS

Also Pre-Engineered Conveyors—
Wheel, Trolley, Roller, Belt
Metal Cleaning and Processing Machines

THE ALVEY-FERGUSON CO., 175 Disney St., CINCINNATI 9, OHIO

Please send me FREE illustrated, descriptive brochures on A-F *Engineered:*

_____ Overhead Trolley Conveying Systems
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_____ Gravity Roller Conveying Systems
_____ Belt Conveying Systems
_____ Apron Conveying Systems
_____ Chain Conveying Systems
_____ Inclined & Vertical Conveying Systems
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_____ Rollers for Gravity and Live Roller Conveying Systems

Without obligation, send an A-F Sales Engineer to discuss: _____

_____

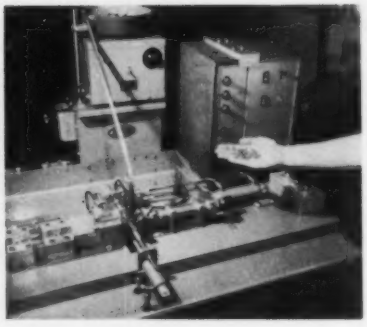
Name _____ Title _____

Company _____

Street _____

City _____ Zone _____ State _____

Circle 680 on Page 155



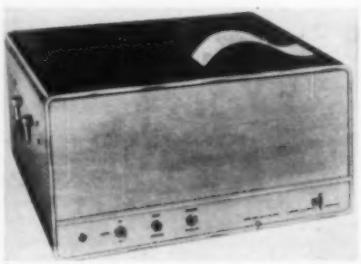
Pigtail Welder

Item 408

Designed for assembling leads to terminal cups for electronic components such as resistors, capacitors, diodes, and rectifiers, automatic welding machine turns out precision welded "pigtail" assemblies at a rate of 3000 per hour. The machine is also adaptable to special types of components such as tantalum capacitors. Wire sizes from 0.025 to 0.050-inch can be handled.

In operation, lead wire is fed from a reel to the welding position where it is straightened and cut to the desired length by a guillotine cutoff blade. End-cups are fed from a vibratory hopper to the welding position, and the two parts are precision-welded. The current magnitude and duration is controlled by a heat program timer. Welded assemblies are ejected into a tote box beneath the machine. **Equipment Marketing Dept., Raytheon Mfg. Co.,** Waltham 54, Mass.

Circle 408 on Page 155

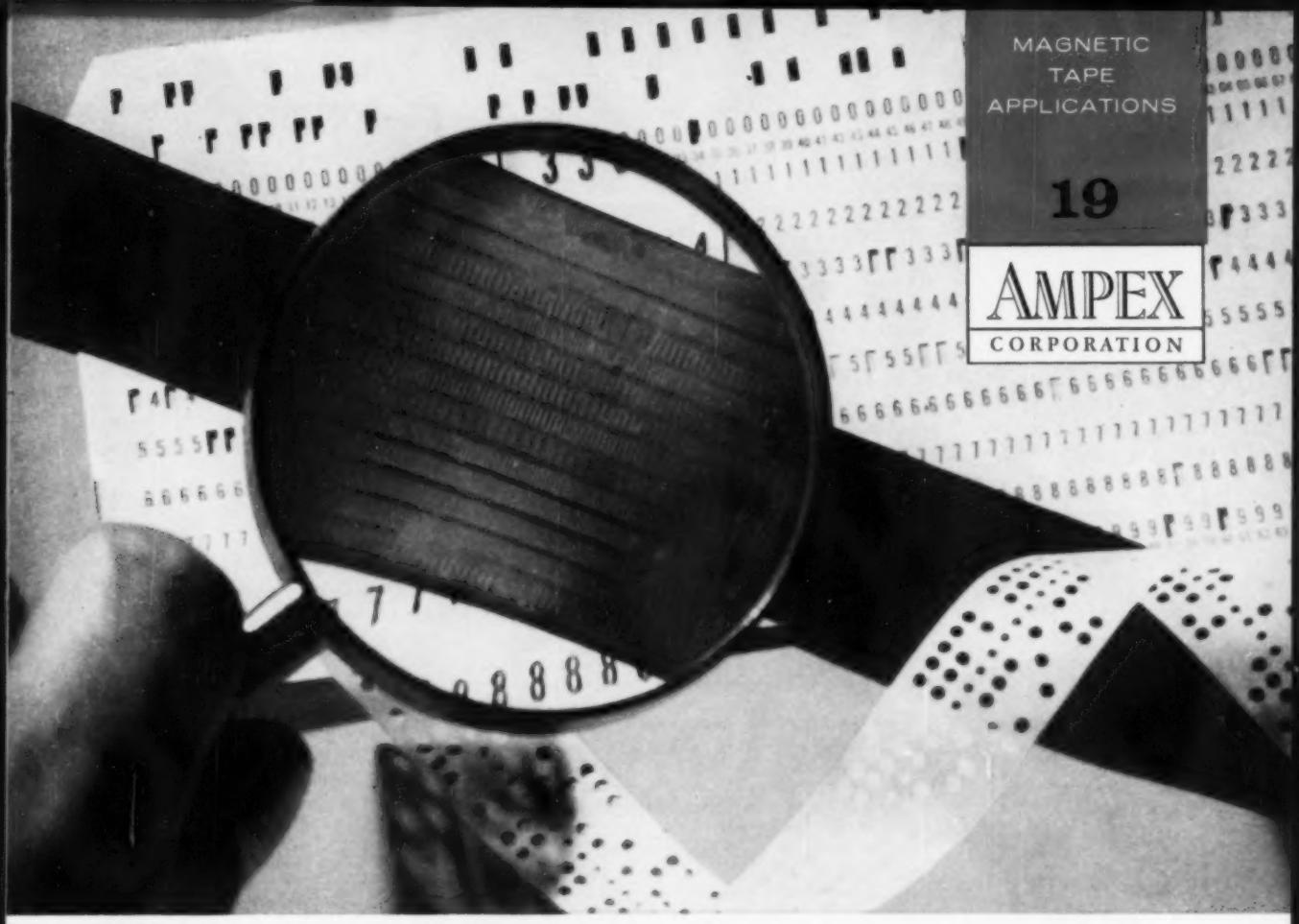


Recording Annunciator

Item 409

Capable of recording equipment operations, instrument has a dual function. It can detect faults at monitored points in the equipment and thus help analyze reasons for failures. Annunciator consists of a

Circle 681 on Page 155→



When to use magnetic tape in automatic control

Iron dust and a magnifying glass provide a revealing visual comparison

You are seeing iron dust clinging to signals recorded on magnetic tape. There can be 3200 extremely reliable binary bits on one square inch—or analog control information similarly compact. In the compacting of automatic control data, magnetic tape is supreme—second only to nature's remarkable chromosome. Nature makes people, dogs, cats and monkeys. Magnetic tape recorders make, for example, machined parts—their shapes the most complex and precise that have ever been produced in quantity. It is done by numerical control. The principles involved are very widely applicable to all kinds of control applications. Three main criteria determine where magnetic tape is your best choice.

Criteria No. 1: QUANTITY OF CONTROL DATA

Any automatic control operation that can benefit from very large numbers of time-synchronized commands is a natural candidate for magnetic tape. For example, continuous-path control of a milling cutter may require X, Y and Z coordinates at several hundred points per inch of tool movement. The more points, the greater the accuracy. A reel of magnetic tape can define millions of points at extremely low unit cost.

Continuous real-time control of variables is applicable to process programming, simulation devices, automatic inspection and electronic-system checkout—provided there is need for great accuracy in a complex situation. The program tapes may incorporate the work of giant computers and intricate interpolating devices. A great advantage of magnetic tape is that the computer and interpolator are used only during tape preparation, hence may be shared with many other needs.

Criteria No. 2: HIGH TRANSFER RATE

The Ampex FR-300 digital tape handler can spew out alpha-numeric characters at rates as high as 30,000 to 90,000 per second. A short burst of digital information equivalent to a standard punched card can be extracted from magnetic tape under 4 milliseconds—including start and stop.

On analog position-control data, magnetic tape can provide many hundreds of complete commands per second—200 per second in one example and up to eight times this many if needed.

On control-system monitoring, a recording of as much as two hours duration can be played back in one minute for review by high-speed computers. Ampex tape recorders with overall speed ratios as high as 120-to-1 are available.

Criteria No. 3: ERASURE AND RE-RECORDING

Magnetic tape can be erased to accept new data an endless number of times. Hence tape-loop recorders can operate on a repetitive cycle of recording, reproduction, erasure and re-recording to serve as time-delay devices or endless monitors. Such a loop can be the analog equivalent of a production line, conveyor belt or process flow. The loop keeps in step, accepts sensing information at one place and then triggers commands at some fixed time downstream. Or as a calamity monitoring device, the tape loop stores information briefly and erases it to make way for new data if nothing has occurred.

Can we advise you on a specific application of magnetic-tape control or send further literature on magnetic-tape recorder principles and applications? Write Dept. M-19.

AMPEX INSTRUMENTATION DIVISION • 860 CHARTER STREET • REDWOOD CITY, CALIFORNIA

Phone your Ampex data specialist for personal attention to your recording needs. Offices serve U. S. A. and Canada. Engineering representatives cover the free world.

clock printer and relay unit which monitors up to 100 points per operational system (smaller units monitor 8 to 32 points per operational system).

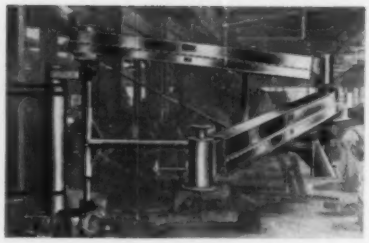
Instrument records the time the equipment goes *Off-normal* and the time it returns to *Normal*. If more than one piece of equipment in the system goes *Off-normal*, and the occurrences are at least ¼ second apart, the information is recorded sequentially. Otherwise, the information is retained and advanced to the printer. Information is recorded in code form on paper tape. The tape is advanced only after a printing. **Panalarm Div., Panellit Inc.**, 7401 N. Hamlin, Skokie, Ill.

Circle 409 on Page 155

Double-Swivel Conveyor

Item 410

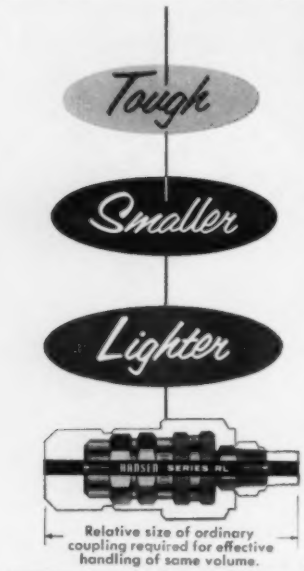
Device is adaptable to handling dry pulverized, crushed, and granular material pneumatically in bulk. The conveyor can feed to various locations, as it is constructed of



two sections coupled together in a double-swivel system. When not in use, it can be folded up and stored.

Each section has parallel upper and lower chambers which are separated by a gas-permeable diaphragm. Air under low pressure is passed from the lower chamber through the diaphragm. It partially fluidizes the material in the upper chamber, reducing friction and giving the material some of the characteristics of a liquid so it flows under the force of gravity. With this conveyor, the discharge end of one length is hinged on a common shaft with the inlet end of the other. Material passes between lengths by gravity. The discharge end of the second length can be swung nearly 360 degrees. **Fuller Co.**, Catasauqua, Pa.

Circle 410 on Page 155



EVERYTHING YOU WANT IN A QUICK-CONNECTIVE PNEUMATIC COUPLING

Hansen Series RL One-Way Shut-Off Couplings will handle any job in your shop using ¾" to ⅛" connections—from the air line to the air tool. All Hansen Series 2-RL Sockets and Plugs are interchangeable with each other. Likewise all Sockets and Plugs of the slightly larger, greater capacity Series 3-RL are similarly interchangeable with each other.

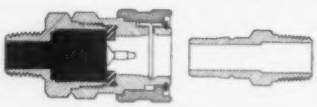
Consequently, by standardizing on either Hansen Series 2-RL or Series 3-RL Couplings, you eliminate any need for various size couplings in your hook-up—make it easy to keep stock of parts in balance—and hold inventories to a minimum.

Machined from solid steel bar stock, Plugs and Sockets are hardened and rust-proofed for long wear. Locking ring provides positive lock and assures tight fit. Equipped with automatic sleeve lock.

THE HANSEN SERIES RL

QUICK-CONNECTIVE RING-LOCK COUPLING

Blue section shows how Socket, when disconnected, automatically shuts off air by leak-proof seal of metal valve against rubber valve seat.



Connected Hansen Ring-Lock Coupling. Blue section shows free flow of air through connected Coupling.

WRITE FOR THE HANSEN CATALOG

Here's an always ready reference when you want information on couplings in a hurry. List complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for L.P. Gas, Steam, Oxygen, Acetylene, etc.

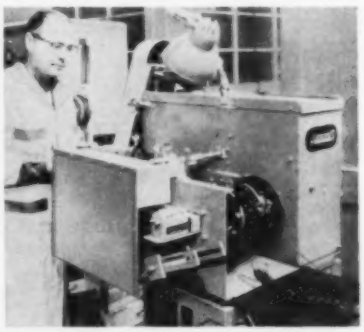
REPRESENTATIVES IN PRINCIPAL CITIES

SINCE 1915 — QUICK-CONNECTIVE FLUID LINE COUPLINGS

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO

Circle 682 on Page 155



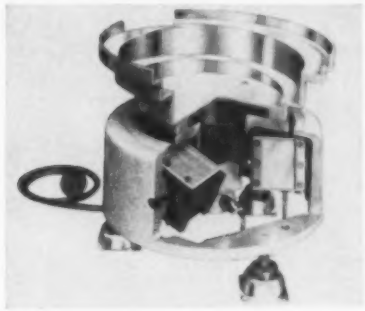
Wire Cutter & Stripper

Item 411

Automatic wire cutter and stripper can process over 9000 pieces per hour for 1 to 40-inch wire lengths, down to 3000 pieces per hour for lengths from 80 to 120 inches. Machine is suitable for different types of wire such as insulated solid and stranded wire and bare solid wire, and for plastic or fabric tubing. Operation is designed to push the wire or tubing instead of pull it. Cutting length limits range from −1/32-inch on shorter lengths

to $-\frac{1}{2}$ inch on 120-inch lengths. Stripping length is held within $-1/64$-inch at each end, regardless of wire length. Length of the strip, when preformed, can be adjusted from $\frac{1}{8}$-inch to 1-inch on each end, or up to 2 inches on one end. **Jennings Machine Corp.**, 3452 Ludlow St., Philadelphia 4, Pa.

Circle 411 on Page 155

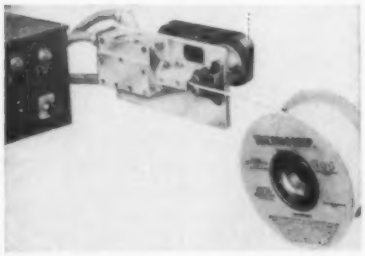


Vibrating Feeder

Item 412

Mechanism is capable of orienting parts such as headless setscrews, plastic parts, metallic stampings, wire forms, screw machine parts, cold headed blanks, powdered metal parts, and cylindrical parts. Production rate is up to 80 fpm. Feeder (cutaway view shown) is energized by three magnetic motors. Larger units use more motors. The mounting angle of the motors can be adjusted so the horizontal and vertical components of vibration suit the particular part being fed. **Arthur G. Russell Co. Inc.**, Forestville, Conn.

Circle 412 on Page 155



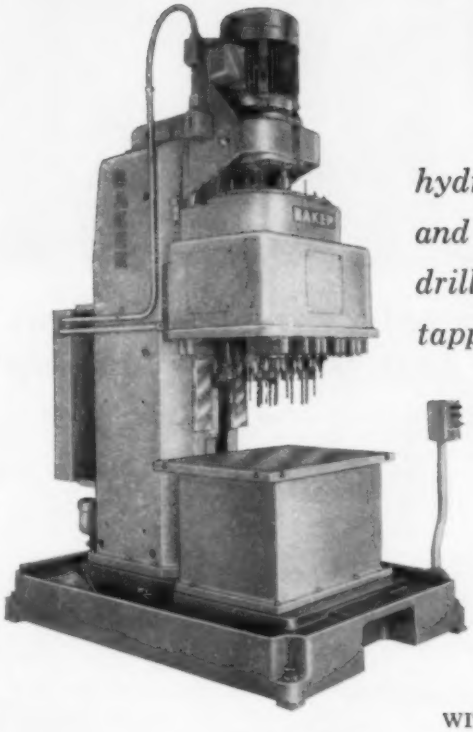
Adhesive Applicator

Item 413

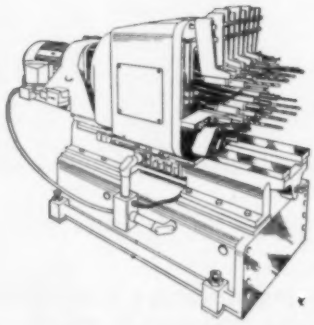
Machine can feed, melt, and apply cord-like adhesives to package ends, tabs, and sides. It is usable wherever an automatic gluing operation is needed. Applicator can

new!

BAKER®



hydraulic vertical and horizontal drilling and tapping machines



WITH NEW STANDARD ADJUSTABLE SPINDLE HEADS

They're here! The new full line of standardized Baker basics — most versatile machines available. Advanced design assures minimum maintenance, permits fastest retooling using standard components. Write for new catalog and name of nearest Baker representative.

NOW . . . COMPLETELY INTERCHANGEABLE!

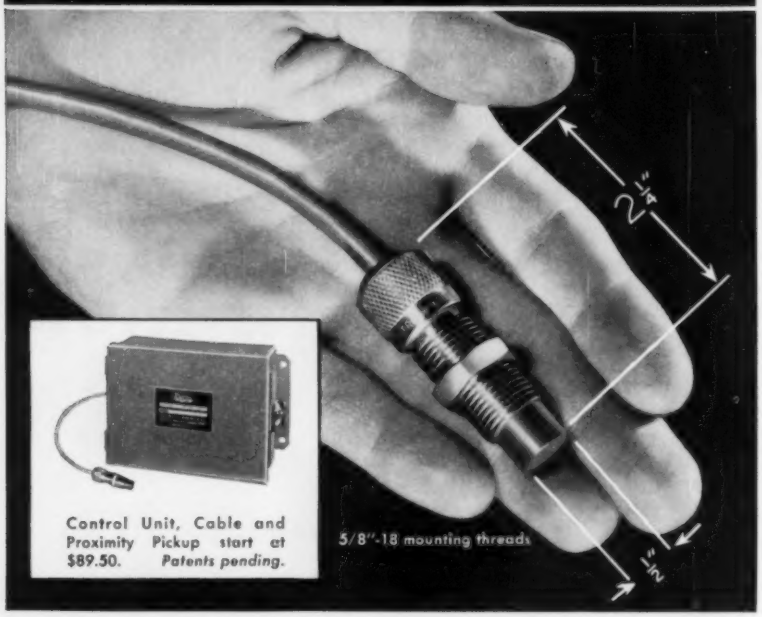
To Fit 3 Sizes **Vertical** Machines — 21 Adjustable Spindle Heads, 27 Fixed Spindle Heads, 3 Types Standard Tables — To Fit 3 Sizes **Horizontal** Machines

BAKER BROTHERS, INC., TOLEDO 10, OHIO

Circle 683 on Page 155

Electro ELECTRONIC EQUIPMENT

First in Proximity Pickups



Solve your metal control problems with this low cost proximity pickup

Compare these advantages over other proximity devices

Flexible . . . Detects both ferrous and non-ferrous metals. Sensitive to very thin metal pieces, such as aluminum foil. Does not attract or hold ferrous chips.

Compact . . . Only the small Pickup need be located in the work area. Control Unit can be located up to 50 feet or more away.

Economical . . . Low replacement cost for Pickup ($13.50).

Rugged . . . Sealed Proximity Pickups for water and oil environments.

Proven Reliability . . . Three years continuous use in automotive industry.

Qualified . . . Meets JIC requirements.

Other "plus" advantages

Versatile . . . Wide variety of Proximity Pickups available for detecting metal objects at clearances in excess of 6 inches. Suitable Hollow Coil or "pass through" type Pickups available for detecting or counting small metal parts of various sizes.

Practical . . . Associated Control Unit contains relay output for direct operation of motor controls, solenoids and electric counters.

Write or Phone for Bulletin and Name of Nearest Field Engineer

8088

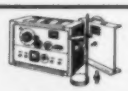
Electro ELECTRONIC EQUIPMENT

ELECTRO PRODUCTS LABORATORIES
4501-U Ravenswood, Chicago 40, Ill., LOngbeach 1-1707
Canada: Atlas Radio Ltd., Toronto

Sensing Elements for Control Counting Speed and Displacement Measurements

D.C. Power Supplies

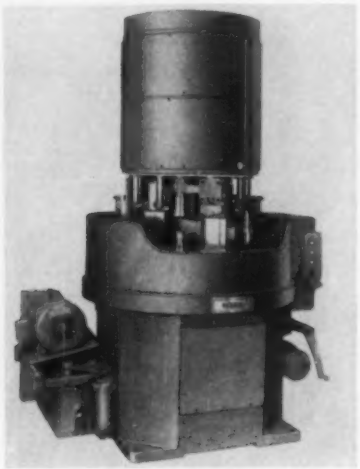
Magnetic Pickups


Sonometer

Dynamic Micrometer

function either on its side or upside down. Incorporating electrical heat controls for exact temperatures, Model CW applies the adhesive to individual passing package surfaces by means of a transfer wheel. The 3/16-inch diameter adhesive is automatically fed from a reel and melted. A variety of adhesives can be used for different applications. **United Shoe Machinery Corp.**, 140 Federal St., Boston 7, Mass.

Circle 413 on Page 155



Four-Spindle Lathe

Item 414

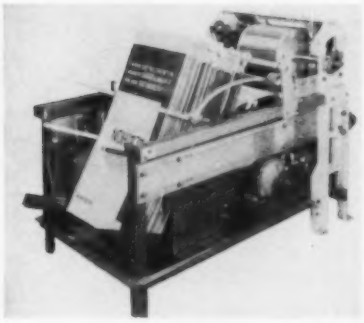
Vertical lathe has four spindles which continuously perform the same operations. No indexing occurs. Each spindle automatically releases the work as it passes through the load and unload sector. Each has precision automatic work-holding, with two longitudinal cutting motions and one cross-slide tool motion in any required combination. A single heavy central column houses the power drive and provides ready access for changeover or servicing of cams and gearing. **Baird Machine Co.**, Stratford, Conn.

Circle 414 on Page 155

Bag Printer

Item 415

Suitable for use with production line filling equipment, automatic machine feeds and prints up to 20 multiwall bags per minute. It can be operated intermittently or continuously. Inking is through felt rollers, an internal ink reservoir, and



a rubber transfer roller. An indexing arm on the drum centers the impression. Interchangeable base-lock rubber type provides sharp legibility. Machine can fit a single bag size or is adjustable for moderate variations in bag sizes. The magazine has a capacity of 250 to 300 bags. **Industrial Marking Equipment Co.**, 655 Berriman St., Brooklyn 8, N. Y.

Circle 415 on Page 155

Tape Dispenser

Item 416

Applicable for production taping of cartons of uniform size, dispenser features two selector arms for measuring tape in either of two lengths from 3 to 75 inches. Two operating buttons are provided, one for each length. The machine can also be operated by remote buttons, foot controls, or photoelectric controls. The desired lengths of tapes are preset on the selector arms, then the operator presses the controls and the machine automatically measures the tape accurately, moistens it with warm water, and cuts the tape. The unit holds one quart of water, has a built-in water heater and a thermostat. Dispenser is rated for 115 v, 60 cycle ac, and draws 3.8 amp. **Marsh Stencil Machine Co.**, Belleville, Ill.

Circle 416 on Page 155

Ask Standard ... how to cut costs with conveyors

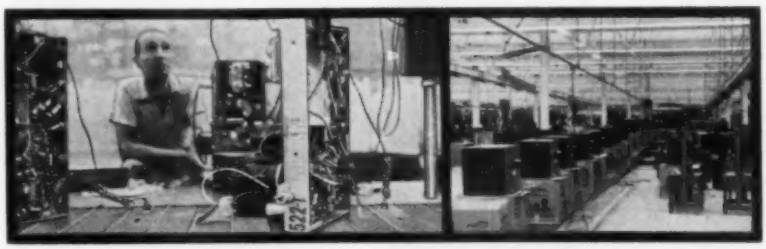
TV chassis move along Standard slat conveyor at right center. Job-tailored design assures uninterrupted, smooth work flow . . . helps manufacturer achieve high degree of automation despite complexity of operations.

Mile-long conveyor system speeds TV production line

In this TV plant, Standard engineers designed and installed more than 2800 ft. of belt and slat conveyors as part of a mile-long conveyor system.

It's a typical example of how Standard engineers will work with you and your engineers to increase automation, cut costs through more widespread use of conveyors.

And, because Standard produces a wide range of permanent or portable gravity and power conveyors — in roller, belt, slat, chain, wheel push-bar and sectional types — you can be sure their recommendations will be unbiased. When you plan any materials moving system, be sure to call or write STANDARD CONVEYOR COMPANY, General Offices: North St. Paul 9, Minnesota.



Left photo shows closeup of slat conveyor. Note integral electric sockets for circuit testing. At right, completed sets move along Standard wire-mesh floor belt.

Contact the Standard engineer listed in your classified phone book. Or, write for free catalog. Address Dept EE-11.

Standard

OVER 50 years of conveyor experience

GRAVITY & POWER CONVEYORS

Sales and Service in Principal Cities.

Circle 685 on Page 155

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Simplify
Automatic
On-Off
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Sandvik's solid, flat band of cold rolled carbon steel gives you these advantages.

- Smooth, Hard, Impervious Surface
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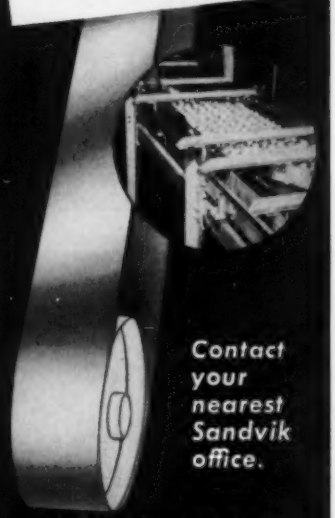
- High Load Capacity and Long Service Life
- Belt Can Be Any Length



Contact your nearest Sandvik office.

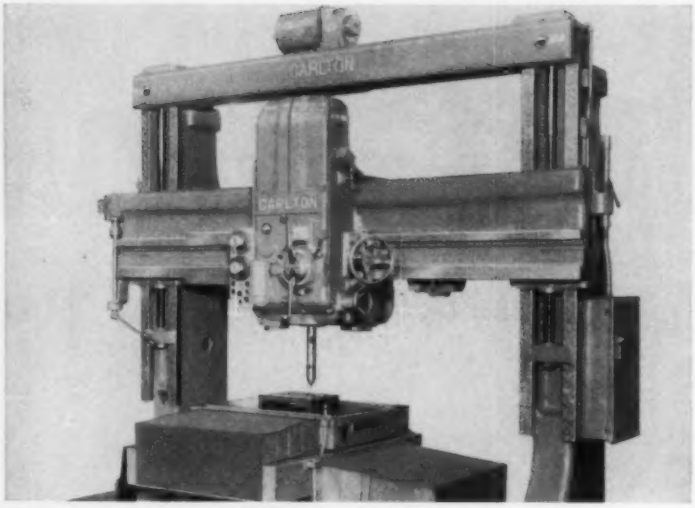
SANDVIK STEEL, INC.
Steel Belt Conveyor Department
1702 Nevins Rd., Fair Lawn, N. J. SWarthmore 7-6200
Cleveland • Chicago • Los Angeles
IN CANADA: Sandvik Canadian Ltd.,
P. O. Dr. 1330, Sta. O., Montreal 9, P. Q.

Manufacturers of Steel Belt Conveyors For Over 40 Years

SANDVIK STEEL BELT CONVEYORS

SS-165

Circle 686 on Page 155

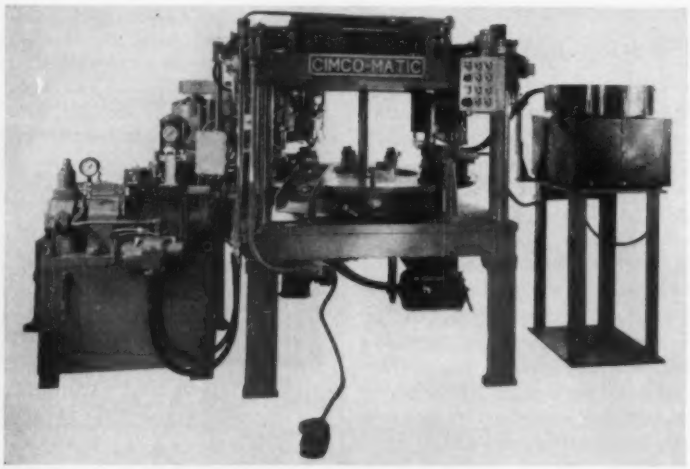


Vertical Drilling and Boring Machine

Item 417

Unit is adaptable for operations requiring heavy duty drilling and boring on a production scale. The vertical drilling and boring machine, of double box column construction, is suitable for use with automatic positioning tables. When the machine is used with a positioning table the need for jigs for heavy duty drilling and boring is eliminated. Features of Model 3AR include: Twin elevating screws for the rails, headstock movable to facilitate loading and unloading of positioning table, a choice of preselect or manual shift spindle speed control, and a hand feed wheel equipped with micrometer adjustment dial for precision depth boring. Unit is powered by a 25 to 30 hp motor. Vertical travel with rail on box posts is 27 inches, vertical travel with spindle in head is 18 inches, horizontal travel of head on rail is 28 inches. **Carlton Machine Tool Co.**, 2961 Meeker, Cincinnati 25, Ohio.

Circle 417 on Page 155



Automotive Ball Joint Assembler

Item 418

Twelve-station machine is designed to assemble the upper ball joint assembly portions of steering mechanisms for automobiles, at a production rate of 600 pieces per hour continuous operation. Both lefthand and righthand ball joint assemblies can be accommodated by interchanging one rest pad and one

diamond locator in each of the 12 fixtures. Equipment includes an index table, a 54-inch diameter dial plate, two greasing units, a hopper feeder, and an automatic ejection unit.

In use, an operator loads sockets into the machine at station 1 and loads lower inserts into a slide fixture at station 2. Operation of the slide moves the lower insert into the machine where a vertical ram transfers the lower insert from the slide fixture into the socket. At station 3, a greasing device operated by a vertical cylinder greases the insert. Parts next index to station 4 where a hopper feeder places an oriented lower bearing on top of the lower insert. At stations 5, 6, and 7 a second operator loads a stud, bearing, and closing disc, and starts a fitting in threads in the closing disc.

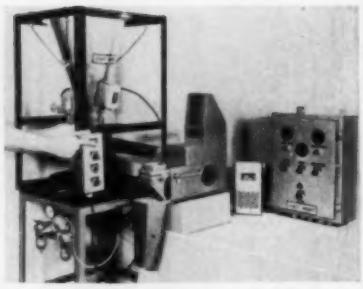
At station 8, a spinning unit rough-spins the socket over the closing disc and a mist spray lubricates the rolls. A second spinning unit finish-spins the socket under mist spray lubrication at station 9. The fitting is seated at station 10. After another greasing operation at station 11, the finished part is automatically ejected at station 12. **Cimco Engineering Co.**, Ann Arbor, Mich.

Circle 418 on Page 155

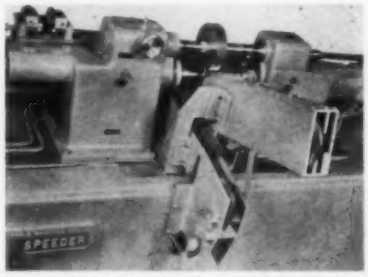
Net Weigher

Item 419

Unit is designed for light capacity high precision net weighing, is suitable for use with material handling equipment. It can provide accuracies of 1/10 gram on quantities below 10 grams and 1 per cent on quantities of 10 grams and above. The unit includes a scale, vibratory feeder, net weigh hopper, solenoid air valve, and direct reading dial. Feeders can handle all free flowing materials. The electrical controls consist of two dial-mounted cadmium selenide crystal photocells which use the high magnification of the scale's projected light beam and shadow indication. Weighers are available in various capacities for different applications. Model 4601 NW-FM-O-10 (shown) has a vibrator on the hopper to prevent material bridging, is also furnished with a support stand. Capacity is up to 50 cu in. per weighing. **Exact Weight Scale Co.**, 538 E. Town St., Columbus 15, Ohio.



Circle 419 on Page 155



Gear Loading Attachment

Item 420

Device is capable of handling gears with large integral flanges, can be installed on gear shaving machines, gear tooth honing machines, gear sound testing machines, and electronic sound discriminator-speeders. Loader features an exit chute close to its input magazine. With this design the gear is automatically displaced axially from its speeding or cutting position in front of the input magazine to a new position in front of the exit chute when the work cycle is completed. Loader size is thus minimized for handling assemblies having a small gear on a large diameter part.

In the application illustrated, the loader is installed on an electronic sound discriminator-speeder. It handles a gear with a large integral flanged member. In operation, a gear in the input magazine rolls into mesh with a master gear. Then the headstock advances a short distance. A tailstock pilot enters the gear, pilots in the headstock nose, and holds the gear by friction. The gear is then speeded in mesh with the master gear in both directions while the resulting sound is analyzed by an electronic sound discriminator unit. At the end of the

SANDVIK
Steel Belt
CONVEYORS
have SPECIAL ABILITY
for automated
handling

Solid, flat band of cold rolled carbon steel—

RESISTS OIL, HEAT AND ABRASION

SIMPLIFIES LIVE BACKLOGGING AND AUTOMATIC DISCHARGE

EASILY FITTED WITH SIMPLE GUIDE AND DISCHARGE DEVICES

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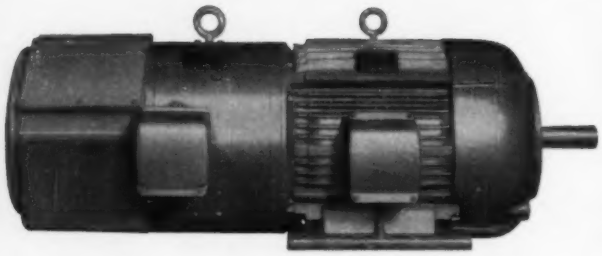
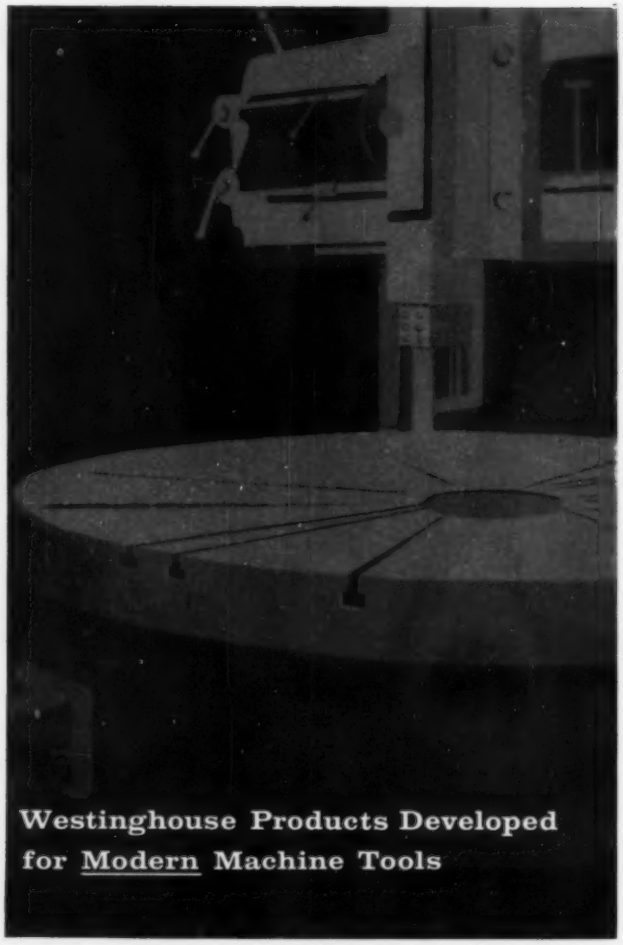
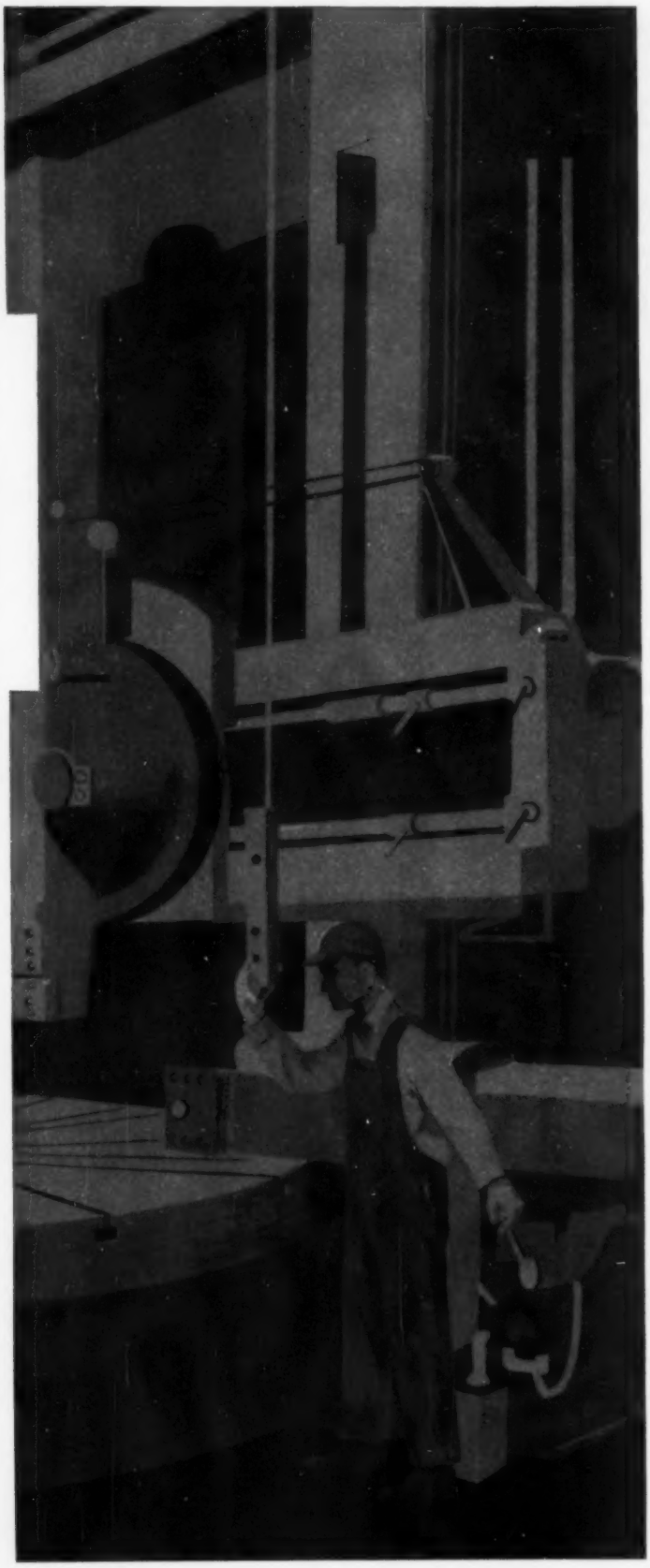
Circle 687 on Page 155

NEW WESTINGHOUSE RECTIFLOW DRIVE



SINGLE, COMPACT UNIT PERMITS ADJUSTABLE SPEEDS DIRECT FROM A-C POWER SOURCE





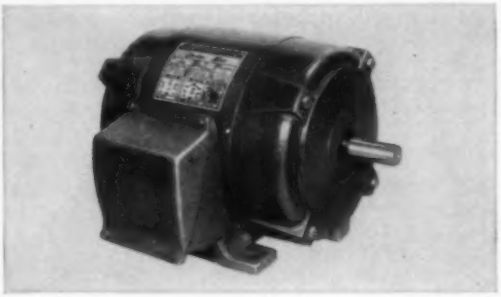
The new Westinghouse Rectiflow* drive gives performance direct from an a-c power source, which was previously obtainable only from a constant-voltage d-c motor with field control.

Completely electrical in a low-maintenance integral unit, Rectiflow is available in constant hp or constant torque, with inherent speed regulation no load to full load of 5 to 10 percent.

Available in TEFC, forced ventilated and dripproof construction, Rectiflow is another example of a Westinghouse product, designed to give the most production at the lowest cost.

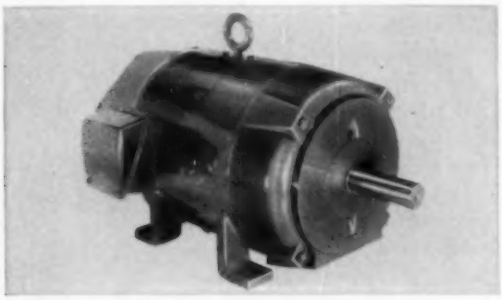
For complete information about Rectiflow drives — and other modern Westinghouse components, ask your Westinghouse Sales Engineer. Or, write Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pennsylvania. J-96111

*Trade-Mark



The reliable Westinghouse Life-Line® "A" a-c motor, part of Rectiflow, combines Bondar®, Bondite and Mylar* insulation for long life. Prelubricated, factory-sealed bearings eliminate need for lubrication — keep lubricants in, dirt out.

*DuPont registered trade-mark



The new Westinghouse Life-Line "H" d-c motor, with revolutionary silicone insulation, gives ten times longer insulation life. New compact design gives fastest response of any industrial motor. New modern housing gives top protection and appearance.

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Westinghouse

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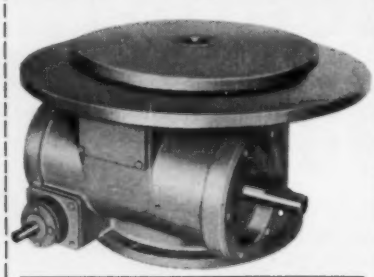
Circle 688 on Page 155

STANDARD TOOL AUTOMATION

Since 1910

New line of Cam-Operated Basic Indexing Units



Size & Model	Positions	Dial Plates	Tool Plates
STA9 B	8 12 16 20 24	18 to 30 inches	36 to 42 inches
STA9 C	16 20 24 32 36	30 to 42 inches	42 to 54 inches
STA9 D	24 32 36 40 48	42 to 54 inches	48 to 66 inches

All these units can be supplied with or without a 10, 20, or 40-1 integral reduction unit. Can also be supplied with 90°, 120°, 180° or 270° cams. Stationary center column available if required.

The great demand for the smaller Model STA9-A basic indexing unit has resulted in an expansion of the Standard Tool basic indexing line. The addition of the Model STA9-B, C, & D makes it possible for you to adapt at least one of these units to your present plans for automation. Please submit your problem for a complete engineering proposal.

Illustrated literature describing Standard Tool Indexing Units —the basis for Automation— available on request.

STANDARD TOOL AND MANUFACTURING CO.

Creative Machine Designers and Builders

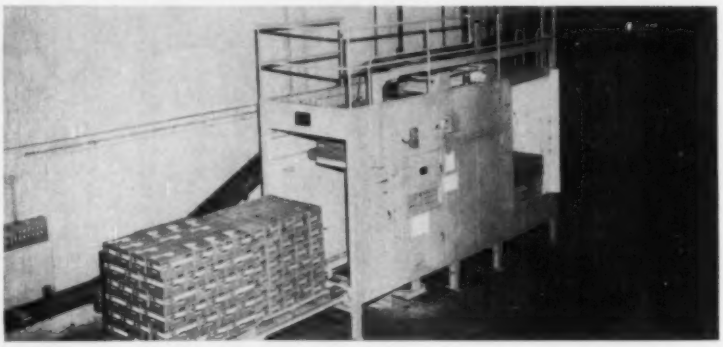
245 LAUREL AVENUE

KEARNY, NEW JERSEY

Circle 690 on Page 155

speeding cycle, a headstock air cylinder moves the gear and pilot assembly to the left as a unit. The tailstock cylinder moves to the left out of the gear, and the gear rolls into the exit chute. The headstock nose then returns to its original position. Gears that do not meet the sound test specifications are dropped out of the exit line by the action of a solenoid-controlled gate. **National Broach & Machine Co.**, 5600 St. Jean Ave., Detroit 13, Mich.

Circle 420 on Page 155

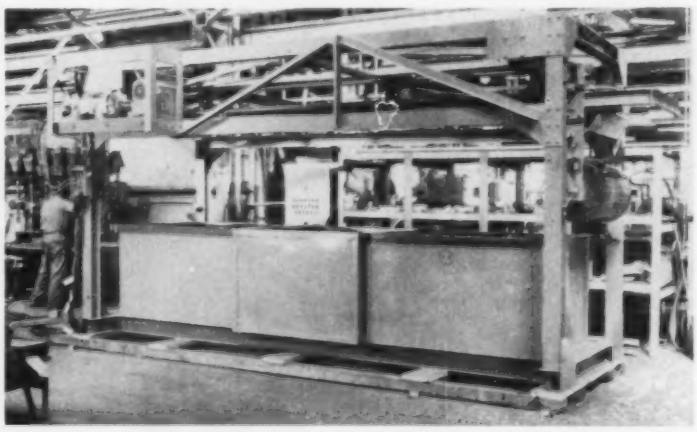


Pallet Loading Machine

Item 421

Loader automatically arranges and places packages on a pallet in a predetermined pattern and quantity. Unit is capable of handling small packages as well as fragile packages. With a conventional seven-case pattern, the machine will move approximately 39 cases per minute. With larger loads using more cases per layer, a speed of approximately 44 cases per minute can be obtained. Motors, hydraulic pumps, control panels, and other components are integral with the machine frame. **Alvey Conveyor Mfg. Co.**, 9301 Olive St. Rd., St. Louis 24, Mo.

Circle 421 on Page 155



Conversion Coating Unit

Item 422

Straight-line, automatic conversion coating machine is suitable for blackening, phosphating, bright dipping, precleaning, and pickling. The unit, which employs a barrel type workholder, can also handle conveying baskets and parts trays. Bulky parts can be suspended from a carrier. Each treatment tank has an individual timer for cycling flexibility. Controls can be set to rotate the barrel continuously, intermittently, or not at all in each tank,

during each transfer, and at the unloading station.

In operation, the door of the barrel opens and closes automatically to receive, process, and discharge the work. After the final solution tank in the treatment cycle, there is an unloading station. Rotation of the barrel at this station actuates a lever mechanism which opens the door and discharges the work. Rotation is continued until the opening is properly positioned to receive the next load. The barrel is then retracted to the loading station. A signal operates a hopper or other loading device to meter out the next load. Another signal starts the barrel rotating again, closing the barrel door. A detent clip holds the door closed during passage through the treatment cycle. **Hanson - Van Winkle-Munning Co.**, Church St., Matawan, N. J.

Circle 422 on Page 155

Data Send-Receive Set

Item 423

Applicable in data processing systems, automatic send-receive set is designed to serve as the center of data processing and message transmission systems. It provides for the direct interchange of transmitted data, recording information in printed page form on message paper or multipart business forms. It produces punched tape as a by-product of transmission and reception, or prepares punched tape at high speed for subsequent transmission. Using a tape reader unit, it provides automatic transmission of data under control of perforated tape.

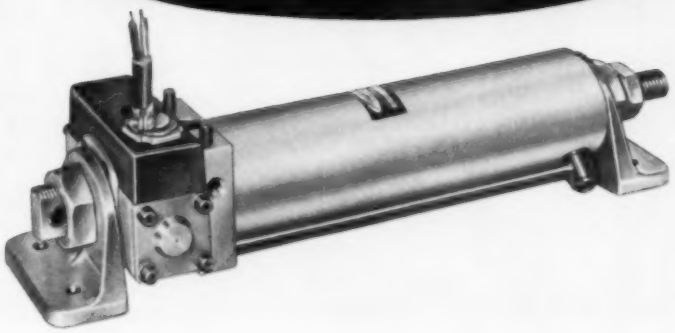
Model 28 consists of a keyboard, page printer, any one of four tape

Now-SAVE SPACE, WEIGHT & PIPING

with **NEW**

Modernair
Trademark

VIH (VALVE-IN-HEAD) CYLINDERS



Here's a combination that's hard to beat — a performance-proved industrial air cylinder with its own built-in directional and exhaust speed control valves — in a single, compact "package". Check these important features:

- **BUILT-IN DIRECTIONAL CONTROL VALVES...** your choice of four control combination; double solenoid, single solenoid with button bleeder return, double button bleeder, or double remote pilot pressure operation.
- **BUILT-IN EXHAUST SPEED CONTROLS** with automatic Nylon lock.
- **INTERCHANGEABLE MOUNTINGS...** front or rear flange, low or high "L" foot brackets, rod and cylinder clevis.
- **SINGLE CONDUIT CONNECTION** for double solenoid unit.
- **AVAILABLE WITH CUSHIONED STOP** either or both ends.
- **PERFORMANCE-PROVED MODERNAIR CONSTRUCTION**

Condensed Specifications

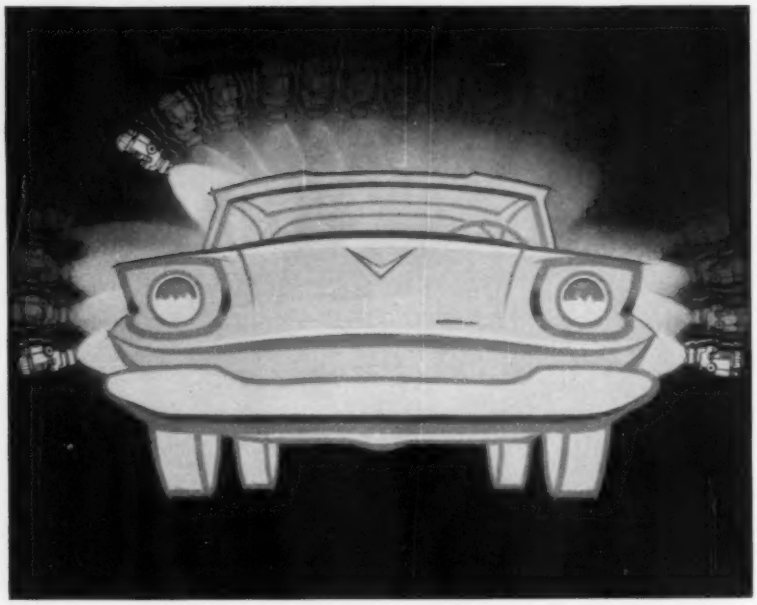
DIAMETERS: 1½", 2", 3"
ROD SIZES: ½", ⅝", ¾"
MIN. OPERATING PRESSURE: 20 p.s.i.
SOLENOID POWER REQUIRED: 10 watts
MAX. OPERATING PRESSURE: 150 p.s.i. (solenoid) 200 p.s.i. (bleeder or pilot pressure)
SOLENOID COILS AVAILABLE: (ac) 8-10, 110, 220 v. (dc) 12, 24, 30 v.

Call your local MODERNAIR sales outlet (see Modernair trademark under "CYLINDERS" in the yellow section of your phone book) or write us today for complete data bulletin; please address Dept. C-11.

Modernair **CORPORATION**
400 Preda Street · San Leandro, California
MEMBER NATIONAL FLUID POWER ASSOCIATION

Circle 691 on Page 155

Mechanized painting eliminates human errors

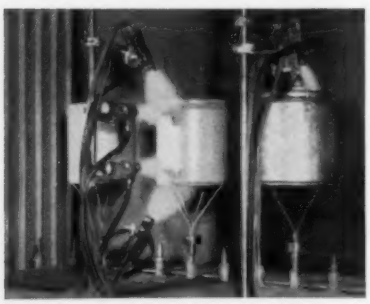


DeVilbiss Automatic Contour Spray Machines are a vital part of the finishing lines in the world's most modern plants, turning out gleaming finishes in a variety of colors at low cost.

DeVilbiss automatic spray machines consistently turn out paint jobs to perfection . . . on products of practically any size and shape. Split-second timing and accurate gun positioning cuts paint waste to a minimum, and ensures absolute uniformity of finish on every part. And these results are attained with high-volume production at remarkably low cost!

But it takes more than just ordinary spray equipment to do the flawless, cost-saving jobs that are demanded today. DeVilbiss meets this demand with experience and know-how that combine the full knowledge of materials, production methods, and spray techniques with the most versatile, efficient automatic spray equipment that's available.

Why not let us test run your product in our Customer Lab — without obligation — for a report of actual costs, plus projected savings over your present system? Our nearby representative will gladly make the arrangements.



Simultaneous painting of exterior and interior of these 5-gal. pails is typical of versatility, efficiency of DeVilbiss automatics.

THE DEVILBISS COMPANY
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FOR BETTER SERVICE, BUY
DEVILBISS

DEVILBISS HELPS YOU GET THE MOST FROM THE SPRAY METHOD

Circle 692 on Page 155

punch units, any one of four tape reader units, electrical service unit, console, and motor. The type of tape reading units available are: Fixed head single-contact transmitter-distributor, pivoted head multicontact transmitter-distributor, fixed head multicontact transmitter-distributor, and pivoted head and fixed head multicontact transmitter-distributor. The types of tape punching units available are: Nontyping perforator, typing perforator, nontyping reperforator, and typing reperforator.

To operate the instrument, the operator selects, by means of a control knob, one of three operation conditions (*Keyboard*, *Keyboard-Tape* or *Tape* setting). In the *Keyboard* setting, the keyboard is used to transmit messages directly to another station or group of stations. A record of the message is made available on the page printer for monitoring, immediate processing, or future reference. In the *Keyboard-Tape* setting, the keyboard is used to perform the dual operations of transmitting messages electrically while simultaneously perforating tape by mechanical means. In the *Tape* setting, the keyboard can be used for direct mechanical perforation of tape at speeds in excess of 100 wpm. In this setting the page printer is available for the receipt of incoming messages or to monitor transmission from the transmitter-distributor. **Teletype Corp.**, Dept. SP-1, 4100 Fullerton, Chicago 39, Ill.

Circle 423 on Page 155

Gun Drilling Machine

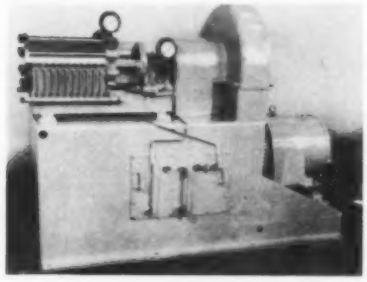
Item 424

Device is suitable for precision gun, or deep hole drilling. It can drill butterfly holes in a carburetor, oil holes in connecting rods, and shaft holes in windshield wiper housings. Drill will function on all types of metal, including stainless steel and high-temperature alloys. Unit can handle two parts simultaneously, is capable of drilling holes from 0.187-inch to 0.750-inch in diameter. Spindle speed ranges from 2000 to 8000 rpm; feed rate varies from 0.0001 to 0.010 ipr, and the feed stroke can be adjusted from 1 to 12 inches.

The cutting tool is driven by a

torque drive adapter, with a contact switch, which protects the cutting tool from breakage. If the gun drill is dull or improperly ground, the torque drive will rotate to the contact switch. The switch takes the cutting tool out of feed and causes it to return to the back position. It also stops the rotation of the spindle, and cuts off the supply of cutting oil. While the machine is in operation, clean, filtered cutting oil is delivered to the rear end of the rotating spindle under pressures from 75 psi to 1500 psi. The oil is forced through the spindle shaft into the drill center, cooling the cutting tip and flushing out the chips to a chip box. **Crescent Tool & Machine Co. Inc.**, 25125 W. Outer Dr., Melvindale, Mich.

Circle 424 on Page 155



Processing Machine

Item 425

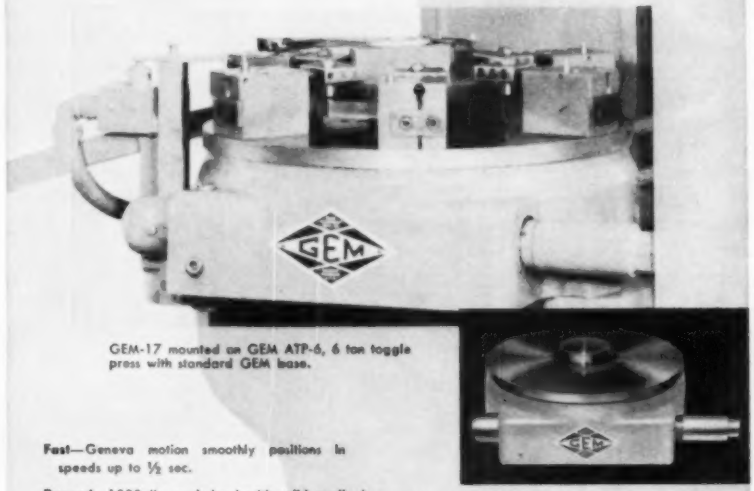
Device is a reactor which combines continuous mixing with accurate process temperature control, transferring heat to or away from materials as it mixes. Machine has many fields of application. It can be used for emulsifying, heating, and cooling in the manufacture of soap, starch pastes, lubricating greases, wax, and photographic emulsions. For functions which require reaction temperature control, it can be used for paint, general polymerization, sulphonation processes, and modifying drying oils. In the food industries, the uses include: Texturizing, aeration, cooking, sterilizing, and pasteurizing.

The machine consists of a series of fixed heat transfer plates through which a heat transfer fluid can be circulated. Electric heating may also be employed. Spaced between each heat transfer plate are beaters mounted on a common shaft. In operation, the beaters mix the material flowing through channels of each transfer plate. This action creates a thin film on the material which in turn gives a high heat transfer rate. Unit has maximum working pressures up to 350 psig, with operating temperatures from 32 to 400 F. Special machines with working pressures up to 1000 psig, with a temperature range to 750 F, are available. **Chemical Machinery Div., Baker Perkins Inc.**, 1000 Hess, Saginaw, Mich.

Circle 425 on Page 155

precision indexing to ±0.001"

. . . WITH GEM-17 DIAL INDEX TABLE



GEM-17 mounted on GEM ATP-6, 6 ton toggle press with standard GEM base.

Fast—Geneva motion smoothly positions in speeds up to ½ sec.

Rugged—1000 lb. work load with solid anvil capacity of 30 tons.

Positive lock—Bolt in Geneva slot cammed both in and out gives positive locking.

Power—Comes complete with rotary air motor, solenoid valve with limit switch (fluid or electric motors available).

Number of stations—6, 8 or 12 standard, 3 and 4 skip.

Size and weight—200 lbs. complete with 17" dia. table (plates up to 36" available).

Geneva Motion GEM-17 Indexing Table standardizes automation on your assembly and machining operations . . . drilling, tapping, riveting, spinning, staking, knurling, chamfering, welding, screwdriving, stud driving and gaging to the speed and accuracy required. Gray's complete engineering staff can adapt the table to your work problem.

Send for Bulletin DI-17 and complete information.

gem

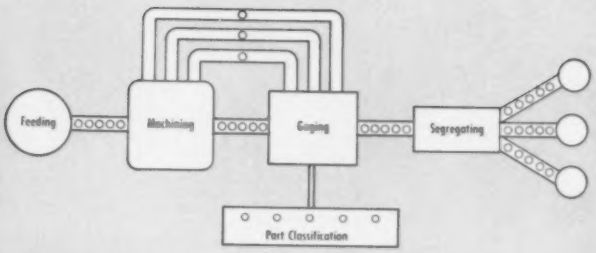
GRAY equipment company

automatic assembly equipment

13600 Ford Road • Dearborn, Mich. • Telephone: Tiffany 6-7573

Circle 693 on Page 155

AUTOMATION DEMANDS *RELIABLE CONTROLS*



Dimensional control is the very heart of automation for the metalworking industry. Consequently, care in the selection of In-Process and Post-Process control devices is very important.

As a long recognized leader in air, electric and electronic gaging, Sheffield is prepared to furnish either:

- **Packaged controls and tooling ready to install**
- **Complete automation gaging and transfer systems ready to operate**

FUNCTIONS and ADVANTAGES

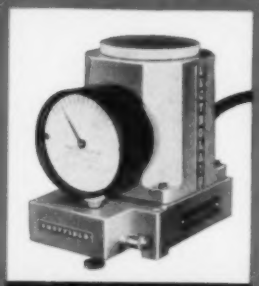
- Determine minute dimensional variations, rapidly and with repetitive precision
- Initiate warning signals
- Actuate control mechanisms
- Segregate acceptable, oversize and undersize parts
- Accurately classify parts by sizes
- Accommodate almost limitless range of tolerances
- Operate with interchangeable tooling
- Are small, compact and easily mounted
- Have unusually long, trouble-free service life
- Are easily interchanged

8153

Shown here are a few of those Sheffield control units so widely used in automated systems.

AIRLECTRIC

A limit type pneumatic control to actuate signals and relays.



LECTROLAIR

A sealed-in control to actuate signals and relays and also to give visual size indication.

DIFFERENTIAL

A gage head for checking taper, hole parallelism or hole center distance and converting the result into an actuating electrical impulse.

VARIATION

A pneumatic gage head for external or internal dimensions and face to axis runout—converts the result into an actuating electrical impulse.

For more detailed information, write for Bulletin AU57-12

The Sheffield Corporation
Division 3
Dayton 1, Ohio, U.S.A.

the **SHEFFIELD** *corporation*
of Bendix Aviation

manufacture and measurement for mankind

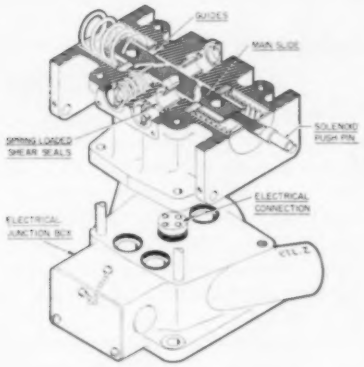
Circle 694 on Page 155

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems

For detailed information and literature, use card page 155.

Electrically Actuated Plug-In Valve



NEED for both pneumatic and hydraulic valves can be found in all parts of an automatic production line. An electronic system that regulates sequencing, timing, and flow of production needs valves. A pneumatic system that furnishes the controlling forces and motions to actuate power equipment needs valves. Material handling and production equipment which can be activated electrically, hydraulically, pneumatically, or mechanically needs valves. With this need for numerous fluid valves in an automatic system where valve failure can shut down an entire production line, a device which features simple maintenance and quick replacement is of primary importance. This idea led to the development of a plug-in valve unit, manufactured by **Whittaker Controls, Div., Telecomputing Corp.**, 915 N. Citrus Ave., Los Angeles 38, Calif.

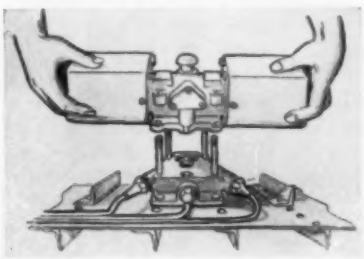
Two Basic Parts

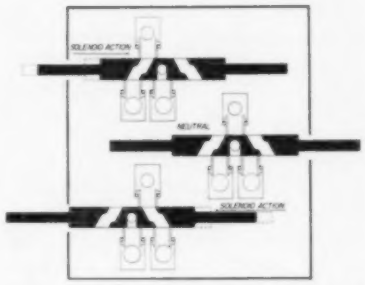
The plug-in valve consists of two basic parts: The manifold, or base, and the body. The manifold is permanently attached to the pneumatic system by conventional pipe threads. Electrical connections to furnish 60-cycle power for the actuating solenoids are permanently made in a junction box which is an integral part of the base. The body containing the movable valve elements and the actuating solenoids is designed with a flat bottom surface that fits against a corresponding top surface on the base. A bayonet electrical connector completes the solenoid circuit. The body surface is equipped with electrical connections and tapered pipe nipples.

Installation is simple; the electrical connections fit into a mating socket while the tapered nipples push against corresponding fluid openings at the base. Each fluid connection is equipped with an O-ring seal. A leakproof connection is obtained by tightening four nuts. To replace this unit requires less than half a minute and the plumbing or electrical connections are not touched.

Valve Construction

Body and base castings of the valve are of diecast aluminum. This material was chosen because it is

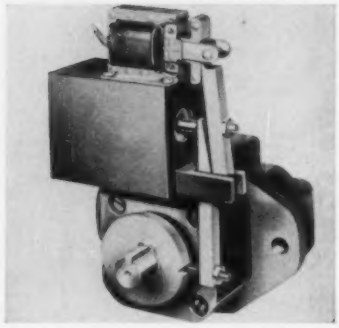




lightweight, resists corrosion, and is economically produced. Flow control is obtained by means of spring-loaded, tubular shear seals which slide against a precision lapped frontal plate. The valve operates without flow restrictions and no lubrication is required. Actuator pins are fabricated of a special resilient material which is shock resistant and functions well under the continuous hammering action of the reciprocating solenoids.

Specifications of the valve are: Air-100 psi rated pressure; temperature range −40 F to +160 F; electrical rating 115 v, 60 cycles, current drain 7 amps inrush, 1 amp holding; minimum flow passage 0.344 inch in diameter; ½-inch port size; weight 14 lb. The valve is designed for automatic controls using shop air but, by changing the materials and seals for specific applications it is adaptable to the chemical processing industry and to the bulk handling of fluids. The castings and other mechanical elements are strong enough to withstand operating pressure as high as 1000 psi and can be reinforced to handle any increases in pressure. This adaptation would permit the automatic handling of any fluid by remote control operation.

Circle 426 on Page 155



One-Revolution Drive

Item 427

Automatic intermittent drive is applicable for indexing motions, feeders, turntables, packaging machinery, and office equipment. Unit is a one-revolution drive, can be arranged for multirevolution operation. It produces an instant high torque using a fluid motor, planetary reduction, and solenoid actuated starter, has a built-in valve to compensate during movement and unload while stationary. A cam and adjustable lever arrangement provide rapid, smooth acceleration and deceleration, and positive stop. Drive is available in a wide range of output torque capacities and speeds. **Constant-Flo Div., John S. Barnes Corp.,** 301 S. Water St., Rockford, Ill.

Circle 427 on Page 155

Indicating Controller

Item 428

Pneumatic instrument controls heating appliances, provides temperature indication and gives accurate proportioning valve operation. It can actuate an air-operated throttling valve to control the flow of steam, water, or gas, or actuate other air-operated devices. Model IVA is explosionproof, can be used in hazardous locations. It includes a fail-safe device for automatic shutdown of the valve in case of air supply failure. Device uses a thermal element operating on a mercury-expansion principle. The control point desired is set by turning the setting knob. A wide or narrow throttling range, within the limits of 3 to 20 per cent of scale range, can be selected by setting a range selector knob. The air pressure between the control and the air-operated valve varies in direct proportion to temperature changes. A rise in temperature at the point being controlled is sensed by the control which modulates the air pressure to the air-operated valve. Depending on the degree to which the heat has risen, the valve will restrict the supply of the heating medium. Control is designed to operate on an air pressure of 3 to 15 psi. It is available in any of 10 temperature ranges between −30 and 1100 F. **Partlow Corp.,** 511 Campion Rd., New Hartford, N. Y.

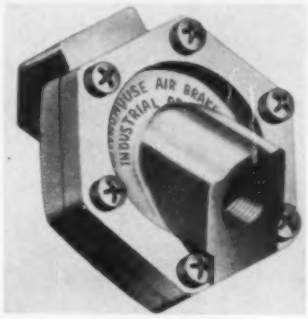
Circle 428 on Page 155

Air Powered Clock

Item 429

Device is suitable for use as original equipment or replacement equipment in all makes and types of recording instruments which record from one-hour to 30-day periods. Applications include integrating orifice meters, strip chart recorders, gas lift meters, pressure recorders, telecounter units, and field program timers. Self-contained unit can be mounted in any position or remotely controlled. Powered by air or gas, the drive unit is explosionproof and internally sealed to prevent corrosion or clogging. All parts exposed to gas are made from aluminum or stainless steel. Device has a gas or air consumption of 5 cfh at its normal operating pressure of 5 psi. **American Meter Co.,** 920 Payne Ave., Erie, Pa.

Circle 429 on Page 155



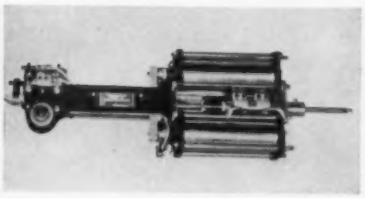
Release Valve

Item 430

Pneumatic device is designed so pressure can be vented in small increments (approximately 6 psi). It can be mounted on a rotating or revolving device and the centrifugal force will not impair its operation. Valve has large internal air passages allowing air to be exhausted quickly.

In operation, air pressure entering the valve through its supply port forces the valve's diaphragm against its exhaust port, closing it. When air pressure at the supply port is reduced approximately 5 psi or more, a differential in the pressures acting on the diaphragm is created. This differential in pressures lifts the diaphragm from the exhaust port and seats it on the supply port of the valve. This diaphragm movement opens the exhaust port, allows air to flow freely from the valve's delivery port to atmosphere, and closes the valve's supply port. If the pressure of the air in the valve drops to a value of approximately 1 psi below that at the supply port, this differential in pressure moves the diaphragm so it seats on the exhaust port, stopping the further flow of air through that port. The supply port can be assembled in two positions; the inlet and outlet ports can be mounted on the same center line or at right angles to each other. **Industrial Products Div., Westinghouse Air Brake Co.,** P.O. Box 36, Wilmerding, Pa.

Circle 430 on Page 155



Drill Press Air Feed

Item 431

Adaptable to all standard single and multiple spindle drill presses, pneumatic feed attachment is designed to convert these machines to automatic or semiautomatic operation. Attachment can handle applications requiring up to 2000 lb total drill point pressure. The drill press feed unit is powered by twin double-acting pneumatic cylinders held in tandem with a hydraulic checking mechanism. This mechanism is supported between the cylinders and is directly in line with the drive rack, providing precision tool control. An adjustment device maintains precise feed settings and controls the cutting tool feed rate and the hole depth limit. The twin air cylinders, which operate at air pressures to 100 psi, supply the thrust for the downward feed of the spindle, and automatically retract it to the starting position after reaching a preset depth limit. The attachment incorporates a valve which assures uniform control of air pressure. **Renco-Aire, Div., Cleveland Pneumatic Industries Inc.**, 64 Old Orchard, Skokie, Ill.

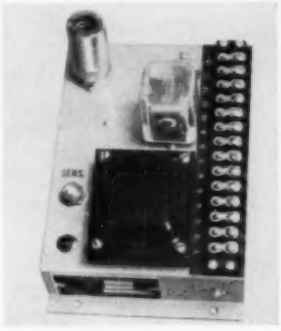
Circle 431 on Page 155

Spring Plungers

Item 432

Line of spring plungers can be used to position parts in jigs and fixtures. The plungers feature a spring compounded and treated to withstand continuous flexing without crystallization. When compressed, the spring allows the plunger to recede entirely into the threaded body. A preset set screw which is sealed in place assures uniform spring pressure. Plunger tips are made of hardened steel. Plungers are available in two styles; a silver-nose (cadmium-plated) model for milder end pressures and a regular heavy-duty type model. Each model is furnished in ten sizes from 6/32 to 1-inch. **Jergens Tool Specialty Co.**, 172 E. 163 St., Cleveland 10, Ohio.

Circle 432 on Page 155



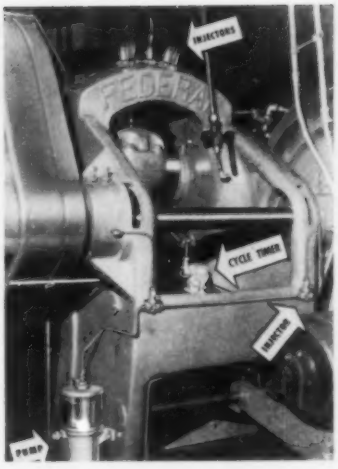
Electronic Relay

Item 433

Device is used in conjunction with resistive type photoelectric scanning heads within 25,000 ohms to 1½ megohms resistance, for applications such as monitoring, filling, counting, detecting, and inspecting. Model PE-3 can also be used with variable-resistance transducers, providing electronic amplification of low-energy signals.

Unit includes a plug-in relay, potentiometer, power supply for external light source, and circuitry. The relay and scanners respond to light changes either lighter or darker, direct or reflected beam. The small signal changes are amplified electronically through a vacuum tube to provide positive relay operation. At six inches between scanning heads, over 2000 beam-interruptions per minute can be counted. Power consumption for the relay is 9 w; power source is 100-130 v, 50/60 cycles. Relay contacts are double-pole, double-throw, 8 amp, 115 v ac, noninductive. **Farmer Electric Products Co. Inc.**, 2300 Washington St., Newton Lower Falls, Mass.

Circle 433 on Page 155



Lubricating Pump

Item 434

Device is designed to provide automatic or semiautomatic lubrication to bearings on single machine units. System is air-operated and controlled either electrically, mechanically, or manually, features easy installation. Two styles of pumping units are available; one model is for low pressure applications of oil, the second model is for high pressure applications of grease or oil. **Lincoln Engineering Co.**, 5794 Natural Bridge Ave., St. Louis 20, Mo.

Circle 434 on Page 155

Temperature Recorder

Item 435

Instrument features a sensitivity and accuracy of 1/1000 C on a full scale of ½ C. Model 102 uses a Brown Instrument strip chart recorder, covers a temperature range of 20 to 30 C. By actuating a selector switch, any ½ C portion of the range can be accurately record-

RIVETING REVOLUTIONIZED by the PAR PROCESS!

PAR ... **Originated by TRS** with the invaluable collaboration of some of industry's top production engineers who sought a major break-through in the automation of assembly operations to reduce costs.

PAR ... **A name given by TRS to its Production Automated Riveting process** . . . continuously developed and perfected for 3 years. Proved successful in some of industry's most efficient plants. Now, TRS has sufficient engineers especially trained in the PAR process to serve all manufacturers.

PAR ... **It makes riveting practically a new fastening method through efficiently integrated and automatic** . . .

1. FEEDING of tubular rivets or related products.
2. TRANSFER of parts between riveter stations by means of sliding or rotating fixtures or dial tables. Or through synchronization with conveyors.
3. SEQUENCING the operation of from 3 to 15 rivet setters which make all fastenings simultaneously or in any desired sequence.
4. CONTROL of setting force as required by parts thickness or material characteristics.
5. SENSING of improper conditions and stopping equipment to avoid injury to parts, equipment or operator.
6. EJECTION of parts as required.

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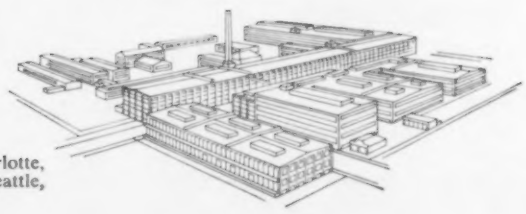
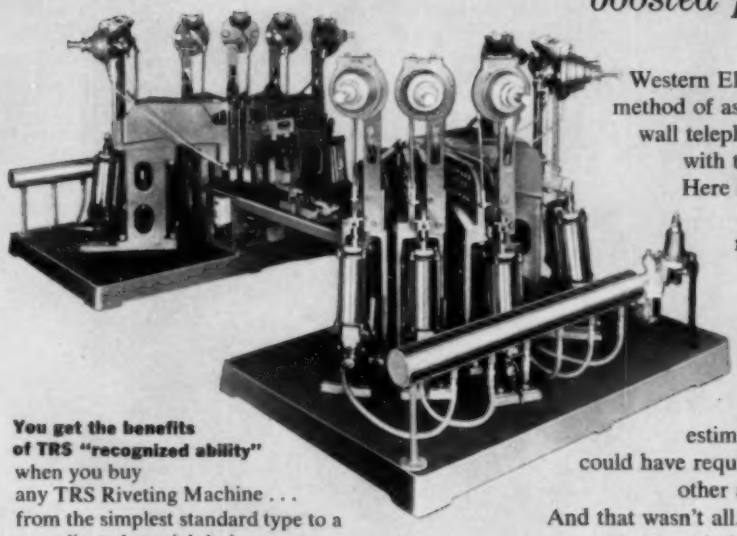


Midwest Office & Warehouse in Chicago. *Branches:* Atlanta, Buffalo, Charlotte, Dallas, Detroit, Indianapolis, Los Angeles, New York City, Philadelphia, Seattle, St. Louis. *See "Yellow Pages" for phone numbers.*

WESTERN ELECTRIC

boosted production rate 80%



Western Electric engineers sought the lowest cost method of assembling the many components of the wall telephone baseplate. TRS engineers worked with them in solving this fastening problem. Here is the specially engineered Multi-Head Riveter that resulted. Ten automatic riveting machines are combined with a specially designed rolling assembly fixture to minimize handling of the five parts of the assembly and, in two fast operations, automatically attach parts to baseplate with ten rivets in a complex pattern. It was estimated that the same assembly operation could have required approximately 35% more labor if other applicable facilities had been installed. And that wasn't all. Later, when production requirements increased, the addition of a second transfer fixture and a second operator boosted the production rate 80%. Western Electric know-how shows in the profitable solution . . . so does TRS ingenuity and experience.

You get the benefits of TRS "recognized ability" when you buy any TRS Riveting Machine . . . from the simplest standard type to a complicated special design.

TRS offers more machines, to more exactly meet your need . . . will lease but likes to sell . . . guarantees performance and sticks by you with all-out service.

PAR . . . It's a TRS Process for very good reasons!

Obviously, there are two critical elements in the PAR Process. Essential is the special and extensive knowledge and experience needed to design an integrated system of standard or multi-head riveters, feeders, transfers and controls for the particular assembly involved. Equally important are superior knowledge and experience in the design, tooling and application of Multi-Head Riveters because these are usually employed.

TRS originated Multi-Head Riveters over three years ago and is the only experienced source of these machines. Further, because this TRS development opened up new possibilities for automating the riveting process, TRS was able to begin three years ago to develop the special experience and application engineers required to fully meet the requirements of the PAR Process.

PAR . . . A New Opportunity to Reduce Direct Labor Charges

With this new help, hundreds of manufacturers . . . large and small . . . can effect substantial savings in direct labor charges, increase production rates, decrease parts spoilage and machine down-time. Look into it now if your product can be riveted, and especially if several rivets are involved.

The yearly amortized cost of the TRS Multi-Head Riveter equipment is low because it will not be obsoleted by changes in product design or production line.

To save more . . . To protect against equipment obsolesence . . . don't buy any Riveting Machines until you investigate the PAR Process

You're not required to use TRS Rivets but you'll be better off if you do

There are no contracts or obligations involved in the PAR Process. However, it is true that the more automatic you make your riveting, the more important it is to use rivets that reduce operating troubles and machine down-time. And, we can give you good, factual reasons why TRS Tubular Rivets are more reliable in essential qualities and uniformity. Ask for the facts . . . judge for yourself.

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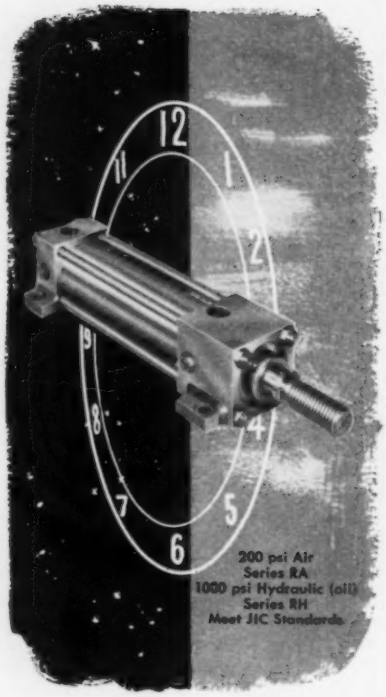
Circle 695 on Page 155



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heavy-duty air and hydraulic cylinders

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Tested, tried and proved in actual service, these ruggedly constructed components hold untold promise for design engineers who seek to combine continuous, smooth dependable and efficient straight line motion with long life and minimum maintenance. Available in 1½" to 8" bores with front flange, rear flange, clevis, trunion or foot mount.

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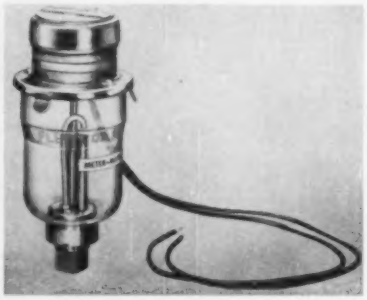
Circle 696 on Page 155

ed. An internal battery provides calibration and balancing. Unit is also adaptable to record different points and cover other ranges. **Fenwal Electronics Inc.**, Mellen St., Framingham, Mass.

Circle 435 on Page 155

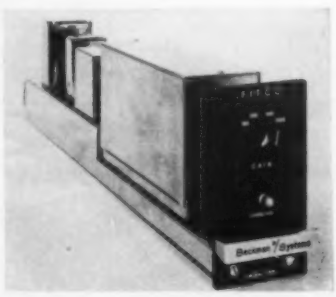


Electric Oiler

Item 436

Device is capable of dispensing lubricating oils, can automatically meter from a drop every 30 seconds up to a drop every 10 minutes. Unit is driven by a synchronous motor. The piston, actuated by a cam, forces the oil drop to a visible point where drops can be checked. The flow is increased or decreased by a cam adjustment. Operation of the oiler is controlled by the main power switch on the machine, providing proper lubrication whenever the equipment is being used. Two styles are available; Model P-115 is rated for 115 v, Model P-220 is rated for 220 v. **Plews Oiler Inc.**, 701 S. Seventh St., Minneapolis 15, Minn.

Circle 436 on Page 155

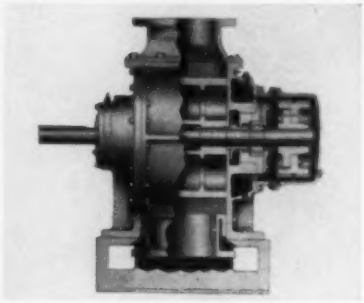


DC Amplifier

Item 437

Low-level device is used to amplify signals from thermocouples, strain gages, pressure transducers, and other sensing elements. It can be used singly or in multiple installations for large data processing systems. Amplifier is composed of solid state components and transistors to provide reliable operation under conditions of extreme shock or vibration. A floating input is utilized to isolate the input from the rest of the amplifier, eliminate false ground loop signals, and permit only the desired signal to go through. **Systems Div., Beckman Instruments Inc.**, 325 N. Muller Ave., Anaheim, Calif.

Circle 437 on Page 155



Positive Rotary Blower

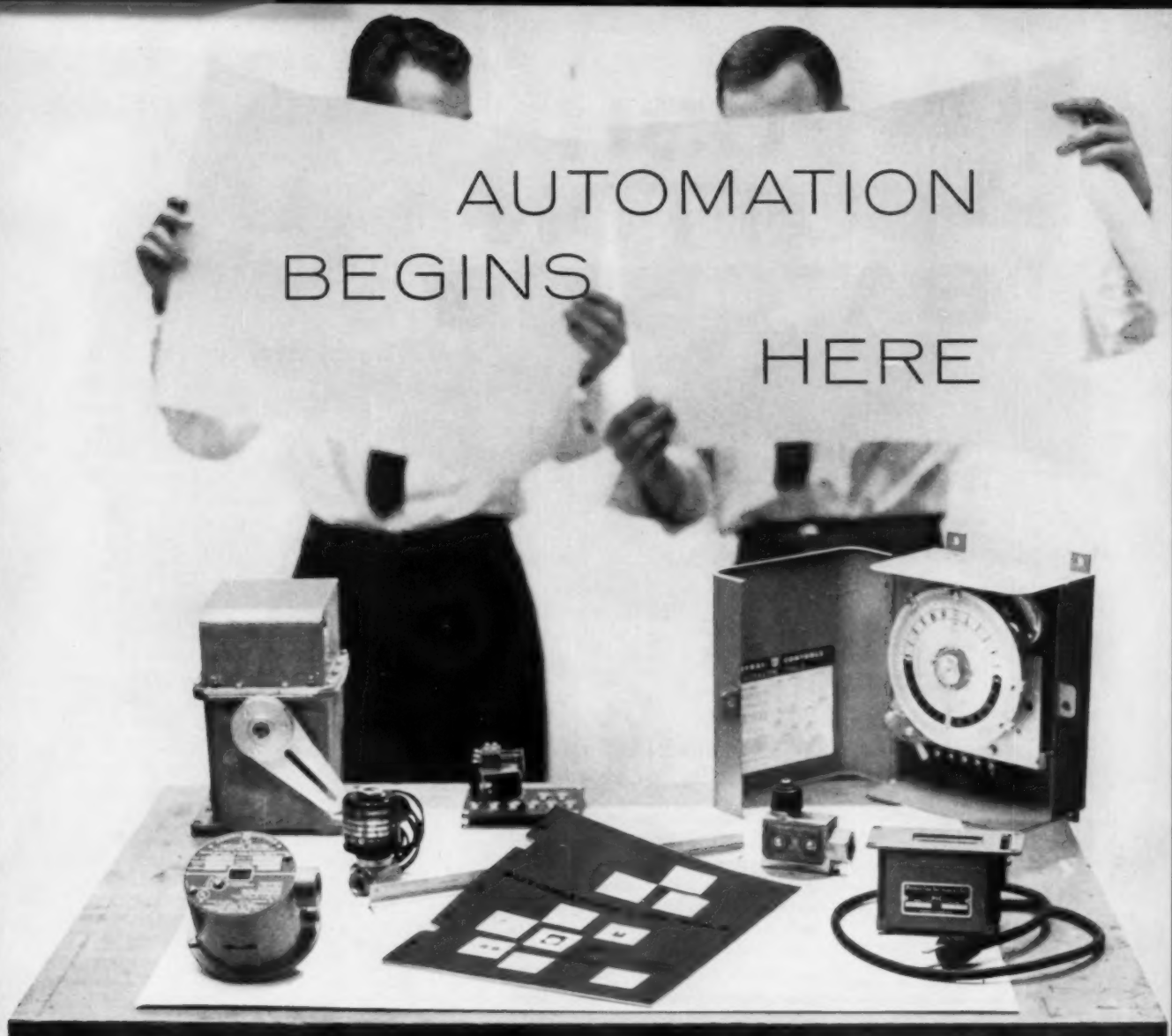
Item 438

Unit (cutaway view shown) is designed to be regulated for varying air volumes by changing blower speeds. When the blower operates with a constant speed against a constant pressure, it delivers a constant volume of air. When speed is increased by means of pulley changes or variable speed drive adjustment, against constant pressure, air volume increases by an amount equal to the blower's displacement times the increased number of revolutions. Unit will deliver air volumes up to 13,000 cfm and pressures up to 10 psi.

Four heavy duty antifriction roller bearings hold impeller shafts in alignment. The bearings are splash lubricated at the gear end of the blower and on the drive end they are lubricated by grease fittings. Timing gears are splash lubricated by oil from the timing gear case at the gear end. Vents are included to prevent over-lubrication. Blower has an adjustable timing hub which permits impeller retiming in the field. **Sutorbilt Corp.**, 2966 E. Victoria St., Compton, Calif.

Circle 438 on Page 155

Circle 697 on Page 155→



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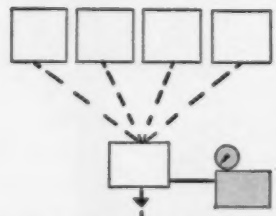
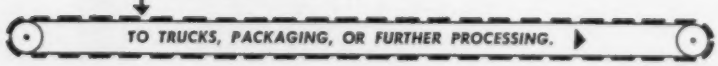
At last, completely automatic one-man batching for you. Batchmaster is the simple, speedy system for precise mixing of multiple ingredients to any desired formula. Accommodates all materials — solid, powdered, granulated, liquid. Provides *continuous* automatic control of all ingredients by weight. Boosts production, improves quality control, eliminates waste.

Simply dial the formula and mixing times, select number of batches, and press start button. Any number of ingredients are automatically fed, weighed, mixed and discharged.

No need for expensive, complex custom installations. Howe engineers *standard* Batchmaster systems tailored to *your* operation. Guarantees proper batching for most critical formulas. Cuts operating costs. Provides better control of material costs. Rugged construction for extreme operating conditions. You have a *different* batching problem? Send for detailed booklet illustrating the Batchmaster solution.





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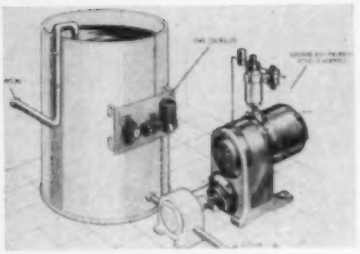


Liquid Level Control

Item 439

Applicable in the food and chemical processing industries, system includes a Varidrive motor which is equipped with a pneumatic actuator. In operation, the motor receives a signal from a level controller which automatically provides variable speed to the pump, thereby maintaining a constant level within the tank.

Two methods are provided to control liquid level in open tanks—air purge and liquid purge. The air purge method uses a bubbler tube, is suitable for use with water and other uniform liquids of low viscosity. The liquid purge method uses a trickle flow of purge liquid, is suitable for use with higher viscosity liquids. System is pneumatically operated, contains no floats or flow restricting valves. **U. S. Electrical Motors Inc.**, Box 2058 Terminal Annex, Los Angeles 54, Calif.

Circle 439 on Page 155

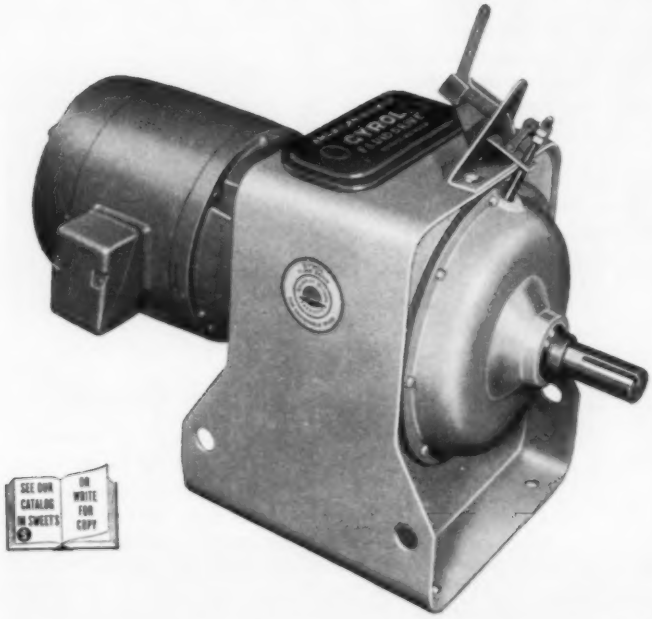
Hydraulic Filter

Item 440

Indicator-type hydraulic filter is designed for 3000 psi service, can be subplate mounted. Unit is constructed so the cleaning indicator can be readily seen and the filter cartridge easily reached. The dual mounting with a four-way valve gives assurance of continuous filtering, with no downtime for cleaning. Filter is available in 10, 20, 30, and

Get full value from adjustable-speed drive:

American Blower *Gýrol*® Fluid Drive varies speed steplessly without costly maintenance

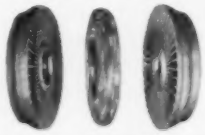


Feature for feature, American Blower Gýrol Fluid Drive is your most economical solution to many industrial-drive problems. Here's why:

- **Stepless speed control**—simple, wear-free speed controller; manual or automatic operation.
- **Shock protection**—vortex of oil isolates shock; protects costly machines.
- **Controlled acceleration**—permits no-load starting—gradual application of power to accelerate the load.
- **Full reversibility**—fast, easy; just change motor rotation even when running; provides dynamic braking.

Compact and self-contained, Type VS, Class 2 Gýrol Fluid Drives come in a complete range of sizes from 1 to 800 hp. Other designs handle up to 12,000 hp. Get full information today from one of our 73 branch offices! Or write: American-Standard*, American Blower Division, Detroit 32, Mich. In Canada: Canadian Sirocco products, Windsor, Ont.

COMPARE . . . THEN SPECIFY *GÝROL*® FLUID DRIVE!

Feature	Shock Protection	Maintenance Record	Accuracy	Service Limit	Horsepower Rating
GÝROL FLUID DRIVE Type VS, Class 2 	Vortex of oil isolates shock.	Good—few wearing parts; extra-long service life.	Simple, wear-free speed control.	Unlimited—all Gýrol Fluid Drive ratings are for continuous service.	Units available up to 800 hp.
FRICTION-TYPE DRIVE	Mechanical connection transmits shock.	Poor—multiple wearing parts; power transmitted by friction.	Wear and tension affect control.	Limited—service factors influence selections.	Units available up to 100 hp.

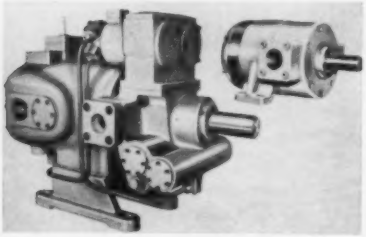
* American-Standard and Standard ● are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
AMERICAN BLOWER DIVISION

Circle 699 on Page 155

60-gpm capacities, with filter cartridges of 238, 149, 74, 40, 30 and 20-micron openings. **Rosaen Co.**, 1776 E. Nine Mile Rd., Hazel Park, Mich.

Circle 440 on Page 155



Piston Pumps

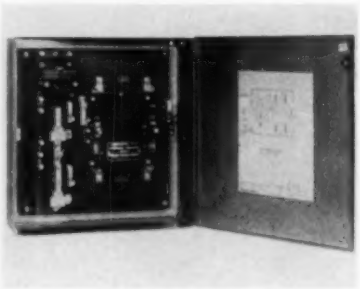
Item 441

Line of integrated axial piston pumps and motors is capable of controlling speed, torque, reversal, acceleration, or deceleration. Units are built in both constant volume and variable volume types. Operating pressure is 3500 psi with 5 per cent intermittent overload to 4500 psi. In operation, pumping action is accomplished by rotating a cylinder barrel assembly. As the barrel rotates, pistons move axially, drawing oil into each cylinder cavity through one of the ports during one-half revolution of the barrel. During the other half-revolution, oil is discharged through the opposite port. Variable volume delivery of the pump is accomplished by varying the inclination of the cam plate and thus varying the stroke of the pistons. By reversing the inclination of the cam plate, pump flow is reversed. A servo-replenishing pump which is driven by the main pump shaft provides supercharging, pressure control, and forced circulation for cooling.

Line of pumps and motors includes 3 styles. The pump in the Series 30 is rated at 3500 psi to deliver up to 38 gpm at 1200 rpm. Torque rating for the fluid motor is 123.6 lb-in. per 100 psi. Displacement is 7.77 cu in. per revolution. The pump in Series 40 is rated at 3500 psi to deliver up to 55 gpm at 1200 rpm. Torque rating of the motor is 179.7 lb-in. per 100 psi. Displacement is 11.3 cu in. per revolution. The 3500-psi pumps in Series 60 deliver up to 115 gpm at 1200 rpm; 5000-psi pumps deliver up to 65 gpm at 1200 rpm. Torque rating for the 3500-psi motor is 373 lb-in. per 100 psi. Displacement is 23.45 cu-in. per revolution. The 5000-psi motors are rated 215 lb-in. per 100 psi with displacement of 13.56 cu in. per revolution. **Denison Engineering Div., American Brake Shoe Co.**, 1160 Dublin Rd., Columbus, Ohio.

Circle 441 on Page 155

LOXSWITCH
—by the Hundreds!
FORD MOTOR COMPANY
Bumper Plant!
Over 500 Denison LOXSWITCH Heavy Duty Limit Switches provide reliable switch control for Ford's new multi-million dollar bumper plant at Monroe, Michigan. LOXSWITCH Limit Switches last for millions of actuations under severe operating conditions. They feature the soundest electrical circuit, the longest mechanical life, plus low actuating force and 70° safety overtravel. All 13 models are water-, dust- and oil-tight at no extra cost! Switch to low-cost LOXSWITCH today.
FREE CATALOG 956 describes single pole-, double pole, multiple circuit and neutral position switches. Send for complimentary copy.
DENISON LOXSWITCH
R. B. DENISON MFG. CO.
102 ST. CLAIR AVE., N. W. • CLEVELAND 13, OHIO
SPECIALIZING EXCLUSIVELY IN LIMIT SWITCHES



Low Voltage Control

Item 442

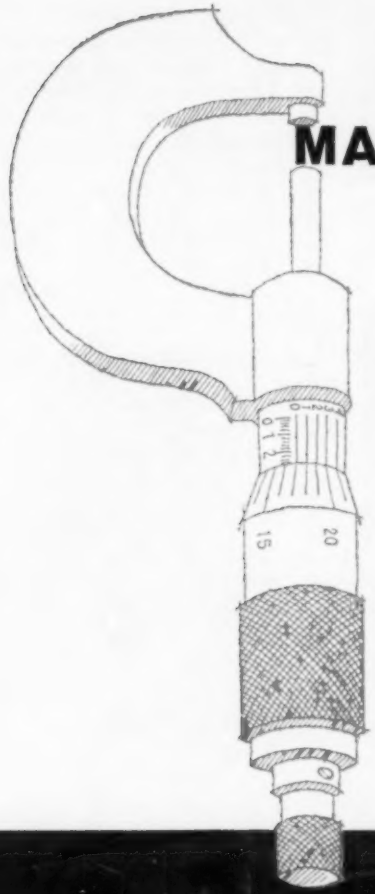
Unit is designed for remote control switches, can be actuated by pushbuttons, time devices, or relays. The switch can be used to control power and lighting circuits. The control unit includes: a switch with fuse adapter, auxiliary contact, and low voltage relay panel. The relay panel has two single pole interlocked controlling relays and a fused step-down transformer unit. No external relays or fuse boxes are needed. Unit is available with capacity to 600 v ac, 200 amp; control voltage of 24 v, 60 cycles. **Automatic Switch Co.**, Florham Park, N. J.

Circle 442 on Page 155

Atomizing Nozzle

Item 443

Pneumatic device can be supplied with two, three, or four heads;



NEED TOP-QUALITY MACHINE WORK?

Call on one of Canco's four complete shops!

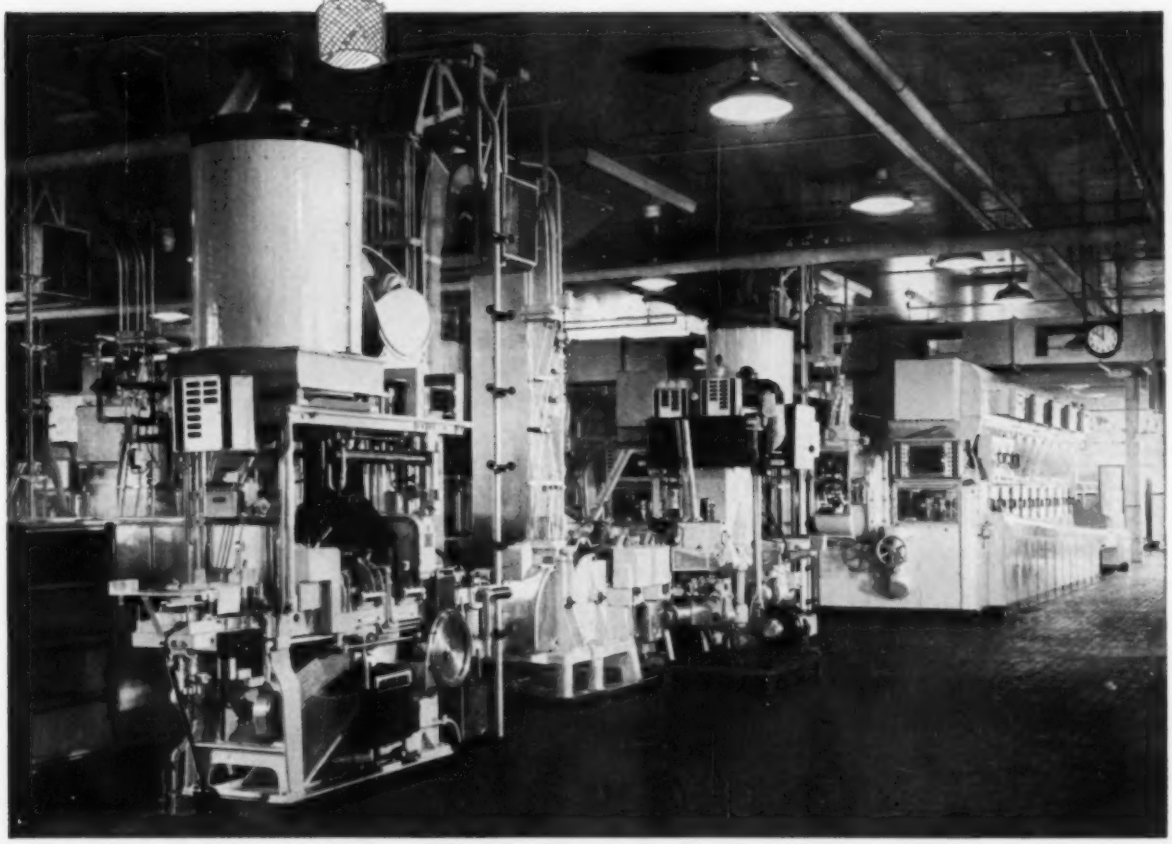
The Nation's largest metal container producer—American Can Company—is a pioneer in AUTOMATION. Its four machine shops produce the equipment which makes AUTOMATION a fact. The machine shops are staffed with experienced engineers, designers and machinists—who can design and manufacture for you any high-speed precision machinery, as well as dies, fixtures, tools and individual parts.

Canco machine shops are located at:

GENEVA, N. Y., North Genesee St. and Lehigh Valley RR • Geneva 8111
NEWARK 12, N. J., 320 Elizabeth Avenue • Bigelow 8-1100
CINCINNATI 23, OHIO, Spring Grove Ave. and Fergus St. • Kirby 1-2381
SAN FRANCISCO 10, CAL., 499 Alabama Street • Market 1-5480

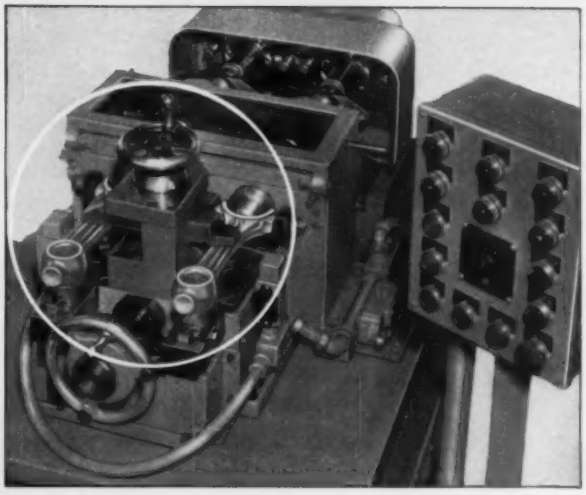
These extensive facilities are available to you for contract and sub-contract work. Your inquiry is invited and should be addressed to the machine shop nearest you.

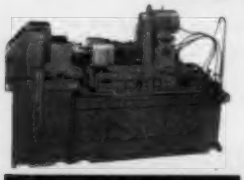
CANCO **American Can Company**



Circle 701 on Page 155

standard gun drilling machine





- **Assures Concentricity, Size and Finish**
- **Handles An Endless Variety of Parts**
- **Eliminates Secondary Reaming Operations**

amazingly versatile

This Standard Machine can be adapted for various depths, and for various size holes, with the smallest amount of fixturing. Concentricity, size, and quality of finish is no longer a problem in any hole—deep or shallow.

completely automatic

Except for load and unload, the entire operation of this New Gun or Deep Hole Drilling Machine, is completely automatic. Automatic load and unload can be provided as an extra feature, if so desired.

torque drive adapter

A Torque Drive Adapter, with contact switch, protects the cutting tools from breakage. If dull drills, or improper grinding, cause excessive torque, feed and rotation of the spindle stops, and it returns to the back position.

coolant under pressure

During the entire operation, clean, filtered cutting oil is delivered to the end of each rotating spindle, under pressures from 75 psi to 1500 psi.

standard specifications

Available speeds 2000 to 8000 rpm. Gun drill diameters .187 to .750. Feed rate .0001 to .010 per/revol. Feed stroke 1.00″ to 12.00″. Maximum stroke of 20″ for tool changes. For longer strokes and for larger drill sizes, other models are available.

For Complete Details Call or Write

CRESCENT

TOOL & MACHINE COMPANY, INC.

25125 West Outer Drive • Melvindale, Michigan

with each head adjustable to any position in a 360-degree range. A typical application is the spraying of lubricant on die faces. Unit measures 1¼ by 2 inches at the maximum cross section and 4-13/32 inches in over-all height with two swivel heads. Nozzle is available in brass or stainless steel. **Spraying Systems Co.**, 3201 Randolph St., Bellwood, Ill.

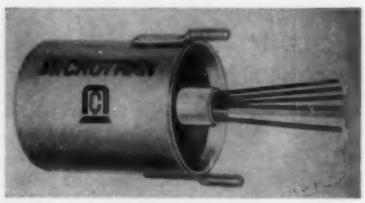
Circle 443 on Page 155

Two-Way Valve

Item 444

Compact, two-way valve with ¾-inch and 1-inch diameter orifices can control media such as air, oil, and water. Unit is explosion-proof, will operate on a pressure differential of 5 to 150 psi, normally open or normally closed. Valve can be directly mounted to a line in any position and can be serviced without removing it. Features of the valve include: a diaphragm supported in both open and closed positions, synthetic inserts for bubble-tight operation, and internal metal parts of stainless steel. **Skinner Electric Valve Div., Skinner Chuck Co.**, Dept. L157, 105 Edgewood Ave., New Britain, Conn.

Circle 444 on Page 155



Chopper Transformer

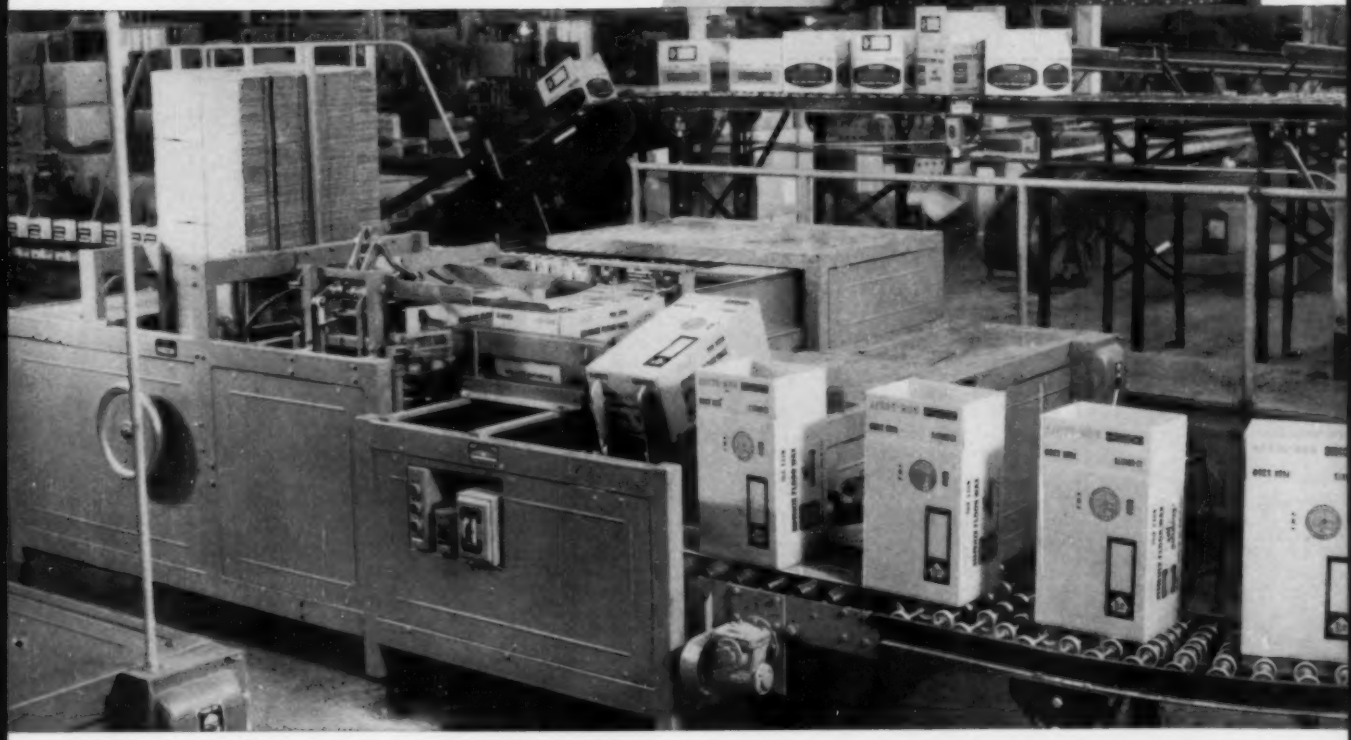
Item 445

Unit is designed to transfer 30 to 500 cps transducer or thermo-

Circle 702 on Page 155

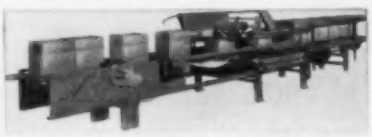
Simoniz
puts "protection"
in a can

Packomatic®
puts the cans in a case



Packomatic equipment feeds, forms, positions, loads, seals and imprints corrugated shipping containers automatically. However you ship—in multi-ply paper bags, or in corrugated shipping containers; whatever you "package"—a can, a carton, a box or a bale—there's a Packomatic machine designed to handle your shipping container requirements. Packomatic machines, geared to your production line, will feed, form, position, load, seal and imprint corrugated containers automatically—or do any of these operations singly as a complement to your existing packaging facilities. Let one of our sales engineers suggest the start of a long-range packaging program for your plant. Investigate the Packomatic method of cutting costs and boosting production. Call, write or wire today.

Fully-automatic Packomatic Case Former-Loader, part of a fully-automated production line at the Simoniz plant, Kankakee, Illinois. Other Packomatics on the Simoniz line include Case Sealers and Case Imprinters.

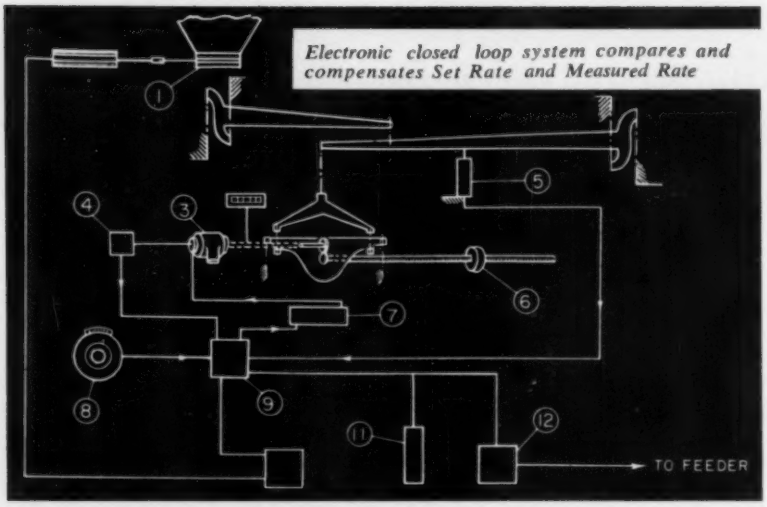


Begin to automate your packaging line with this high-speed, fully-automatic Case Sealer. Aligns loaded cases, positions flaps, glues, seals and discharges — and no operator needed! Available in wide range of sizes. Semi-automatic, too. Call or write for additional information.

J. L. FERGUSON CO. Joliet 2, Illinois

PACKOMATICS include the Bale Sealer • Case Sealers • Opener-Loaders • Case Imprinters • Telescoping Volumetric Fillers • Packer-Gluers • Semi-automatic or fully-automatic.

Circle 703 on Page 155



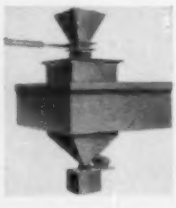
New Continuous Formulating System

Combines Thayer Scale's superior mechanical accuracy with the sensitivity of electronic compensating controls

Instantly responsive to 0.1% rate deviations in accuracy.

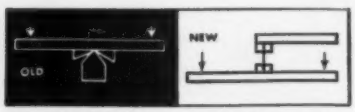
Thayer announces a radically new weight control system for processing hard-to-handle solids or liquids. This new loss-of-weight system provides rapid formulation with high sustained accuracy at rates up to 5 tons per hour.

A material hopper, (1) supported on a Thayer Flexure Plate Scale, is automatically filled to a selected weight and the scale is brought to balance by connecting a servo motor (3) and weight transducer (5) through a relay matrice (9). The poise (6) is then retracted, at a set rate (Dial 8), a potentiometer selects a voltage and a tachometer (4) measures the poise retraction rate. These variables are compared and differences are amplified (7) and sent to the servo motor maintaining zero error. The transducer senses deviations from balance and sends a signal to the controller (12) determining the rate of discharge. Should the system abort, an error circuit (11) will sound an alarm and interrupt the operation.



Thayer Scale

This closed loop system will maintain a constant speed control over long periods and its accuracy is not dependent upon wearing parts. The operation can be programmed by means of Thayer AUTOWEIGHTION Punch Cards. Indicators and recorders can be installed at remote locations.



THAYER FLEXURE PLATE LEVERAGE SYSTEMS are guaranteed to retain their accuracy for the life of the scale. Vulnerable knife-edge pivots are replaced by non-wearing Thayer Flexure Plates.* Neither dirt, shocks nor vibration can effect their accuracy. **Write Thayer about any problem you have controlling processes by weight.**

**Also utilized in Thayer Batching, Filling and Checkweighing Scales.*

THE Thayer SCALE

***THE THAYER SYSTEM OF PROCESS CONTROL BY WEIGHT**

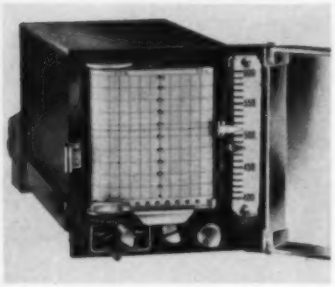
AUTOWEIGHTION

THAYER SCALE CORP., 5 Thayer Park, Pembroke, Mass.

Circle 704 on Page 155

couple signals to instrument amplifiers. Signal level ranges from 0.5 mu v to 0.5 v. Low-level chopper input transformer is resin impregnated to minimize mechanical vibration noise signals. The use of 3 mu-metal and 2 copper shields provides low hum pick up. Center taps and external electrostatic shield connection improve the low-level operation. **Microtran Co. Inc.**, 145 E. Mineola Ave., Valley Stream, N. Y.

Circle 445 on Page 155

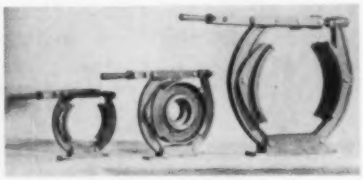


Control Station

Item 446

Instrument is adaptable to process computer systems. In operation, the station receives a 3-15 psi pneumatic signal from the computer. This signal is the value at which the measured variable should be maintained to obtain optimum yield. The computer signal is continuously indicated, and the controlled variable is continuously recorded and indicated. Another indicator shows valve top-pressure. Self-contained unit has a four-position switch for manual, automatic, or computer control of the process; the fourth position permits a smooth transfer between manual and automatic. **Bristol Co.**, Waterbury 20, Conn.

Circle 446 on Page 155



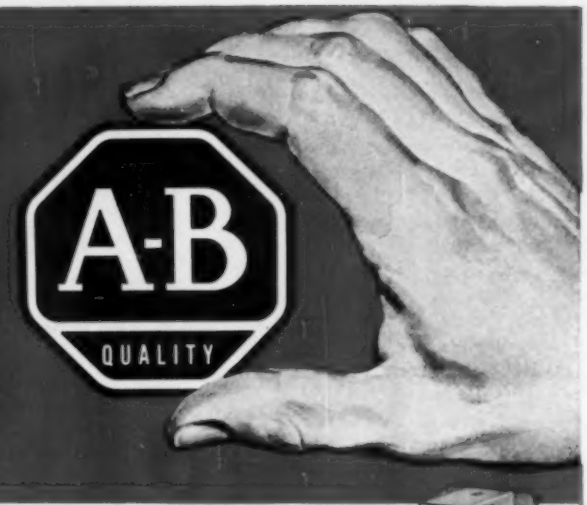
Post Type Brakes

Item 447

Devices are designed for use with company's speed reducer pulleys, and are available for 7, 10, and 16-inch

AMONG DESIGN ENGINEERS . . . ALLEN-BRADLEY IS THE PREFERRED CONTROL!

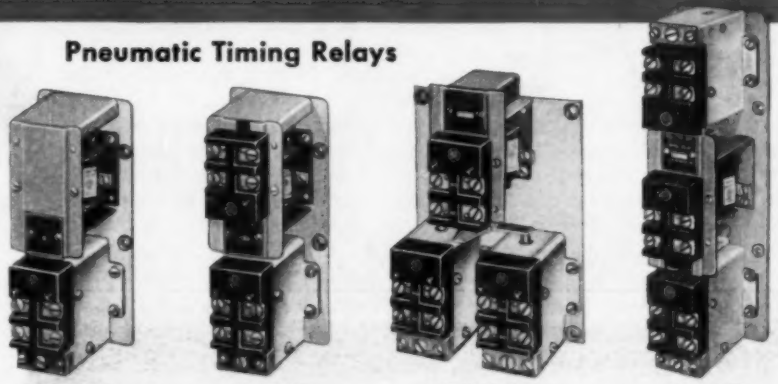
THE "SIGN" OF trouble free TIMING RELAYS!



Pneumatic Timing Relays

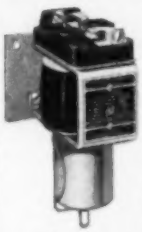
BULLETIN 849

These versatile timing relays are available in a variety of types for either "on delay" or "off delay." Delay time is adjustable from 1/20 to 180 seconds with an accuracy of ± 10%. Maintenance free silver alloy contacts. Additional auxiliary contacts easily added. A.C. or D.C. operation.



STANDARD UNIT | AUXILIARY CONTACTS ADDED | TWO TIMING UNITS | COMBINED ON-OFF TIMER

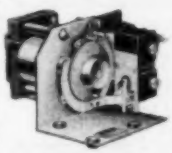
Fluid Dashpot Timing Relays



BULLETIN 848

For applications where reliability is more important than accuracy. As the viscosity of the silicone fluid does not vary with temperature, the timer's accuracy is ± 15% from −30°F to + 120°F. Can be easily adjusted from 2 to 30 seconds.

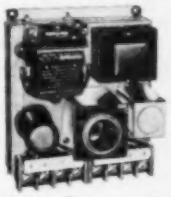
Motor Driven Timing Relays



BULLETIN 850

Driven by a Telechron motor, this timer alternately opens and closes two switch units. Made to provide 2, 3, 4, or 6 operations per minute on 60 cycles. Running and drift time on both contact units are easily adjustable.

Electronic Timing Relays



BULLETIN 852

An accurate and flexible A.C. timer, designed for frequent operation. Can be recycled rapidly over long periods. Time delay is dial adjustable over a range of 20 to 1. Repetitive accuracy ± 2%. Eight units provide time delay of 0.025 to 120 seconds.

This broad line of timing relays carries the traditional Allen-Bradley trademark of *quality* that stands for trouble free operation. The rugged construction and maintenance free, silver alloy contacts have made them first choice among men in the field . . . engineers, consultants, and contractors. You just cannot go wrong when you specify Allen-Bradley control . . . by name!

Allen-Bradley Co., 1339 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

Circle 705 on Page 155

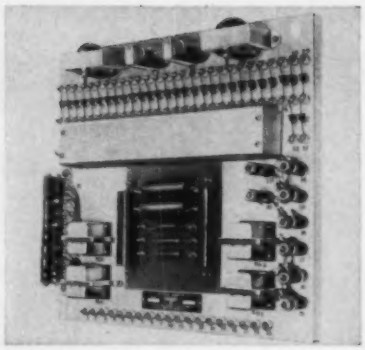
drums. Holding capacities are 10,000, 25,000, and 130,000 lb-in. Positive brake pressure, through a single-action toggle lever, can be locked by moving the lever over center. Individual swivel mounting of the brake shoes provides self-alignment for uniform pressure regardless of the direction of drum rotation, with the load carried by anchorage. The pressure is controlled through an adjusting screw and lock nuts on the brake lever end. Braking action causes no pull or strain on the drum shaft bearings. The brake linings are the heavy duty woven type, riveted in place, and can easily be replaced. **Hart Reduction Pulley Co.**, 1116 Adams St., Waukesha, Wis.

Circle 447 on Page 155

Power Supply Monitor

Item 448

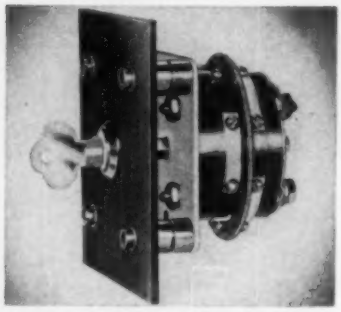
System is designed to detect variations in conditions of voltage, frequency, and phase in power sources. It will operate contactors, switches, or alarms in response to these conditions by de-energizing



the load or switching it to another power source. As the power is shut down or switched over, the monitor will relay a signal to a visible or audible alarm and indicate the fault. After a shutdown or switch over, the monitor can be reset automatically or it can be left energized to indicate and identify a fault which occurred during an unattended period.

Capacitive time delays are provided as a protective measure to eliminate tripping the alarm device for a brief variation in conditions. The capacitor discharge is used to supply the tripping current, and this current will not flow until the capacitors have become charged. So, if the variation is cleared in a short time, the alarm device will not be tripped. Model 4.010 is rated for 6 to 440 v, 5 amp or 600 watt relaying capacity, frequencies are from 25 to 1600 cps, response time is 0.2 second, accuracy is ±2 per cent of setting, and the time delay range is from zero to 15 seconds. **Electric Regulator Corp.**, Pearl Street, Norwalk, Conn.

Circle 448 on Page 155

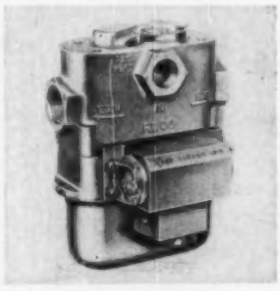


Key-Operated Switch

Item 449

Rotary switch can provide control of up to three sections and eight positions. The key serves as a knob and when it is removed, it locks the switch in any one of the eight positions. This feature assures tamperproof protection of electrical circuits. Up to three sections can be specially assembled to handle complex electrical circuits. Switch is rated 10 amp, 125 v ac, or 5 amp, 125 v dc. **Electro Switch Corp.**, 167 King Ave., Weymouth 88, Mass.

Circle 449 on Page 155



Three-Way Valve

Item 450

Unit is adaptable to pneumatic clutches or power presses which are controlled by a clutch-brake. Assembly includes two three-way

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Circle 706 on Page 155

valve units connected pneumatically in parallel. Each unit has a pilot valve operator and solenoid actuator. An attached unit supplies inlet air to the pilot valve operators.

In operation, when the valve senses an unsafe condition, the attached unit renders the valve inoperative and halts the press at the end of the cycle. If the valve is within reach of an operator, it can be reset manually. When the valve is not within reach of an operator, it can be remotely reset by providing air pressure at the recock port from a small valve. **Ross Operating Valve Co.**, 120 E. Golden Gate Ave., Detroit, Mich.

Circle 450 on Page 155

Interval Timer

Item 451

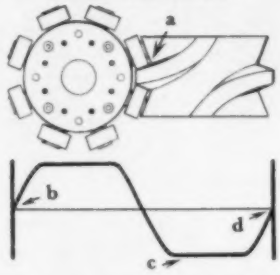
Device has five independent channels, is designed to provide accurate switching operations at precise time intervals for electrical circuits. Timing cycles can be as short as a second or as long as several hours. Timer includes a synchronous motor and a cam and positive action contact arrangement. In this arrangement, one set of contacts makes the circuit and the other set breaks the circuit. Contacts are designed for a load current of at least 0.5 amp. The speed of the contact operation is independent of the speed of rotation of the cams. Tolerance of timing pulses is held to plus or minus 1/5 of one per cent. Total contact bounce on the circuit make is less than 300 microseconds, and less than 50 microseconds on the circuit break. Unit will operate at various input voltages on dc or 60 cps and 400 cps ac. **Western Design & Mfg. Corp., Div., U. S. Industries Inc.**, Santa Barbara Airport, Goleta, Calif.

Circle 451 on Page 155

Critical Points in Acceleration Characteristics of Indexing Devices

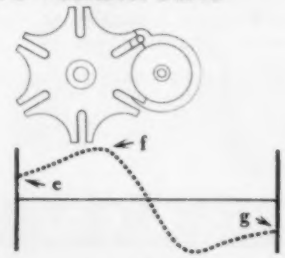
Maximum speeds of production machines are frequently affected by performance limitations of their indexing mechanisms. The efficiency of the indexing mechanism, itself, is dependent upon the amount of shock, vibration and other dynamic forces involved in the starting, stopping and rate of change from maximum acceleration to maximum deceleration.

FIG. 1 · · FERGUSON DRIVE



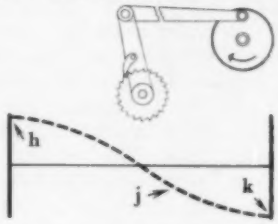
The acceleration curves of such mechanisms provide a graphic means of evaluating and comparing dynamic conditions that affect the performance of the indexing device and the machine. The Ferguson Drive in Fig. 1 is a cam indexing mechanism employing preloaded bearing followers rolling along a tapered cam rib. Two followers are in contact with the rib at all times (a) maintaining a zero backlash condition and an accuracy of .001" without auxiliary locating devices. This Drive features a modified trapezoid acceleration characteristic . . . a combined cycloidal and gravity curve. The Ferguson Drive has an initial force of zero (b) and a smooth, sinusoidal increase. Its maximum acceleration value (c) is very low and the change through maximum deceleration to zero (d) is gradual. These smooth indexing characteristics of the Ferguson Drive permit operation of production machinery at speeds as high as 2,000 RPM, if necessary, with a minimum of 8,000 hours operation while maintaining extreme precision and zero backlash.

FIG. 2 · · GENEVA DRIVE



The six-stop geneva drive shown in Fig. 2 is representative of the geneva family in that its dynamic forces are instantaneously applied and the initial acceleration force is fairly high (e) with an even higher maximum acceleration (f). The change to maximum deceleration is gradual but there is an almost instantaneous stop (g). When operated at high speeds, geneva drives wear out quickly and cause heavy vibrations that seriously affect the life of the machine and product quality.

FIG. 3 · · RATCHET & CRANK



The rachet and crank has a distorted cosine acceleration curve (a true cosine curve is illustrated in Fig. 3) with an extremely high initial acceleration (h) The descent to maximum deceleration (j) is gradual but, as with the geneva drive, stopping is instantaneous (k). Even with auxiliary braking action, overtravel is extreme and accuracy is very poor. Rachet and crank devices have very limited use in modern production machines.

FIG. 4 · ·

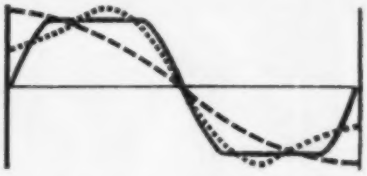


Fig. 4 shows the curves of the three mechanisms on the same diagram. Note that only the Ferguson Drive has an initial force of zero and the lowest maximum acceleration value combined with a gradual change to maximum deceleration. *This is why the Ferguson Drive does what no other indexing device can do!*

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Complete information about the Ferguson Drive is available in the form of an easy-to-use catalog containing load ratings and dimensions of many standard units, drawings and installation photos. There is a copy for every design engineer . . . for your copy write: **Ferguson Machine Corp., 7818 Maplewood Industrial Court, St. Louis 17, Missouri.**

Circle 707 on Page 155

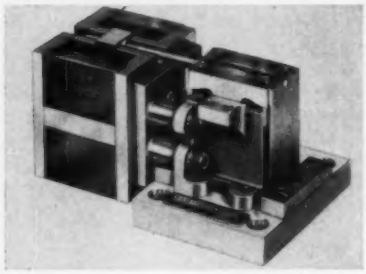
Photoelectric Relay

Item 452

Relay control device with a miniature light source and photocell holder is suitable in counting, diverting, sorting, detecting, and inspecting applications. It can be used to energize magnetic counters, conveyor switching devices, magnetic contactors, and motor starters. Unit can also be used to indicate overtravel, level, or obstructions on production lines. The transistorized relay will function at a rate of 300 operations per minute; the miniature light source and phototube holder will operate at a lightbeam distance up to eight feet.

Unit includes a control panel, light source holder, and photocell holder. The control panel also supplies power to the light source. The circuit is designed for snap action closing of the output relay contacts. Maximum rating of the contacts is 5 amp. **General Electric Co.**, Schenectady 5, N. Y.

Circle 452 on Page 155

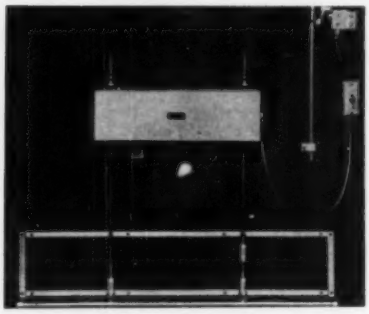


Servo Valve

Item 453

Unit can be applied to controls on pumps and transmissions to provide greater system accuracy and resolution. Electrohydraulic servo valve has only two moving parts; a torque motor armature and a swing-plate. The flow rate is a linear function of valve displacement, supplying high fluid power gain with minute swing-plate movement. Spring steel supports in the swing-plate respond instantly to low torque motor forces. Because the torque motor armature pivots on a torsion shaft, the valve automatically centers in event of power failure. Flow rate is 4 gpm at 250 psi, 8 gpm at 1000 psi pressure drop across valve. The torque motor has maximum power demand of 5 watts, differential current of 150 ma, resistance per coil of 80 ohms. The valve, open or enclosed, can be gasket-mounted. **Oilgear Co.**, 1571A W. Pierce St., Milwaukee 4, Wis.

Circle 453 on Page 155



Press Safety Control

Item 454

Designed for wide-bed punch presses, automatic press control is also adaptable to small hydraulic or air-clutch operated presses. Model 87-A has a twofold function. It acts as an emergency stop when anything goes wrong with the dies or the work, and it serves as a safety device which stops the press instantly if the operator's hand is in the danger zone when the ram descends. The main control box is mounted directly on the ram and has a retractable trigger-bar which extends across the front of the press. This bar precedes the ram on the downstroke. If the hand of an operator is within the danger zone, the control bar automatically stops the press. If the work is incorrectly positioned, the operator can stop the press by touching the control bar. **W. I. Martin & Co.**, 3059 W. Armitage Ave., Chicago 47, Ill.

Circle 454 on Page 155

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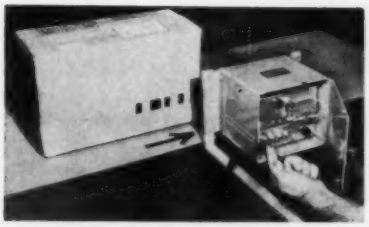
Circle 708 on Page 155

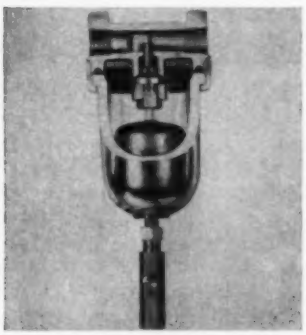


Carton Selector

Item 455

Device can automatically select, by means of a 5-bar code, any type case, box, or carton as it moves along a conveyor or material flow line. Model 410 also provides an output signal which can be used to activate a conveyor switch to direct the flow of goods for further processing. Items are separately coded with the 5 vertical bars. The code can be printed on the cartons at the same time other printing is done and no special inks are needed. Up to 30 different codes are possible. The selector switch is then set to recognize the code as the cartons pass at speeds up to 180 fpm. The selector can be reset to recognize a different item by a control behind a locked cover. **Atronic Products Inc.**, One Bala Ave., Bala-Cynwyd, Pa.

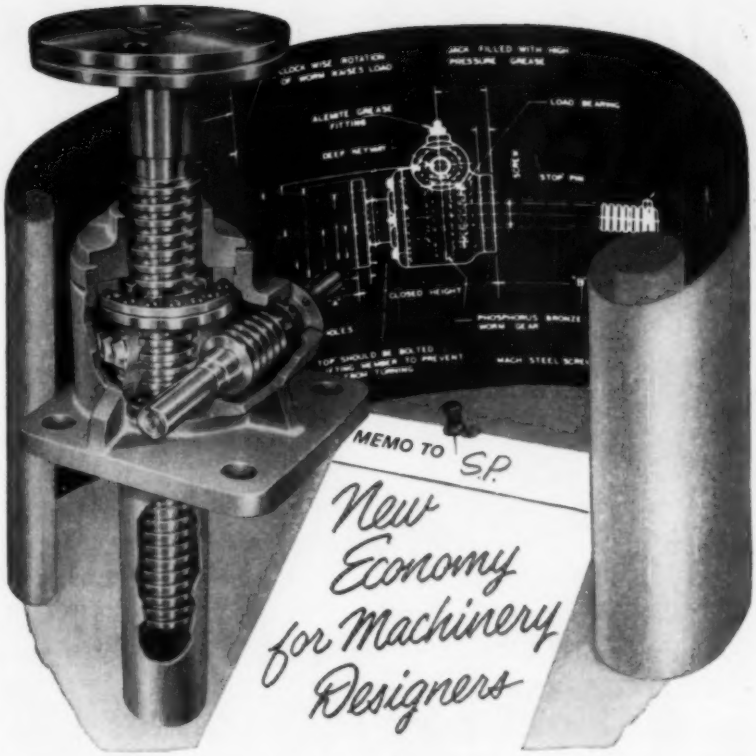
Circle 455 on Page 155



Lubricator System

Item 456

Automatic filling lubricator maintains a constant oil level in bowl and can be used alone or in combination with airline filters and regulators. The lubricant is automatically supplied by pipe line, direct from 55-gallon drums at a central pumping station to any number of lubricators. Unit is available in pipe line sizes of ¼-inch through 1-inch. Lubricators



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Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting Bulletin AD-66-GG, which includes drawings and full specifications.

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Circle 709 on Page 155

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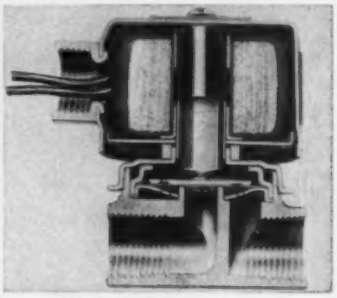
Circle 710 on Page 155

which are hand filled can be converted to the automatic type by using a lubricator bowl with a sensing valve. **Arrow Tools Inc.**, 1972 S. Kostner Ave., Chicago 23, Ill.

Circle 456 on Page 155

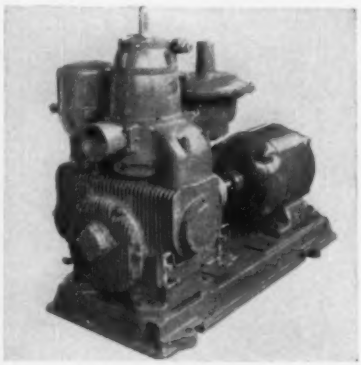


Solenoid Valve

Item 457

Unit is suitable for the flow control of water, air, low pressure steam, light oils, and brines; can be used in air compressors, spray lubrication systems, and pneumatic tools. Valve features pilot operation, has only two moving parts. It is available in 5/16 and 3/4-inch port diameters, can be mounted in any position. **Controls Div., Jackes-Evans Mfg. Co.**, 4427 Geraldine Ave., St. Louis 15, Mo.

Circle 457 on Page 155



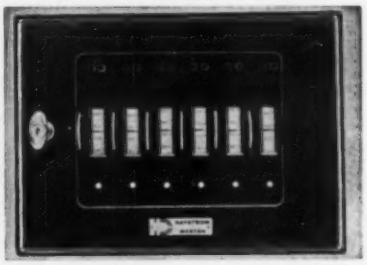
Gas Proportioner

Item 458

Unit is capable of mixing two or more gases at a preset ratio regardless of variations in mixture pressure and total flow. It is suitable for use as a gas combustion controller in industrial heat processing for the operation of automatically controlled gas-fired furnaces and heat processing machines. Rated maximum capacities are from 500 cfh to 75,000 cfh at pressures up to 100 psi.

Device is comprised of a dual-port mixing valve, and either an integral vane-type positive displacement pump or a centrifugal compressor. It is designed so the total port area varies in response to changes in pressure-drop across the valve while the ratio of individual port areas remains constant, once it is set. The ratio adjustment can be automatically operated in response to control signals from an appropriate gas analysis sensing device. Mixture ratios can be held within 0.2 per cent from 10 to 100 per cent of rated capacity. Special interior linings are available for use with mildly corrosive gases; it is not recommended for highly corrosive gases. **Selas Corp. of America**, Dresher, Pa.

Circle 458 on Page 155



Nonindicating Controller

Item 459

Multipoint instrument is applicable for continuous control where there is no need for a chart record. Model 6134 uses an electronic amplifier, operates on the null balance principle. Only one amplifier is used in the switching arrangement. Up to six independent slide wires and control set points make each individual control unit independent from the rest. Scanning cycle is adjustable to 2, 5, or 10 seconds per point. A hold-in type relay maintains the correct control setting on each point. Set points are adjustable by large thumb wheels extending through doors next to each scale window. Unit is rated for 115 v ac, 50 or 60 cycles. With an external transformer, it can operate on 220 v. **Daystrom-Weston Industrial Div., Daystrom Inc.**, Newark 12, N. J.

Circle 459 on Page 155

Pressure Transmitter

Item 460

Type 13AA d/p produces a 3-15 psi linear signal proportional to absolute pressure, is accurate to 0.5 per cent of full scale. It is capable of operating standard receivers over long distances. Transmitter is built around a capsule-type, twin-diaphragm sensing element. Process pressure is brought into the high pressure chamber. The low pressure chamber acts as a reference, with process pressures continuously compared to the absolute zero pressure. As the force is applied to the capsule, it acts through a force bar, a flapper-nozzle mechanism, a feedback bellows, and a relay to produce the measurement signal and maintain the balanced condition of the transmitter. Measurement ranges are adjustable between 0-50 and 0-250, or 0-200 and 0-850 inches of water absolute. Maximum operating temperature is 250 F. **Foxboro Co.**, Foxboro, Mass.

Circle 460 on Page 155

Pneumatic Vibrator

Item 461

Pneumatic device is suitable for bin, hopper, chute, railroad car, and batching applications. It can be used under conditions where there

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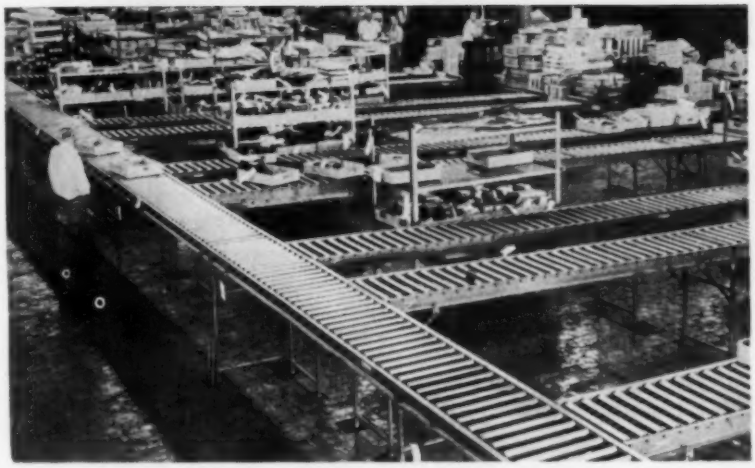

Lines of roller conveyer used for packaging of tractor repair parts where orders are made up for shipment.

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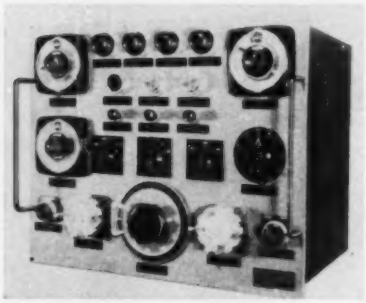
Circle 711 on Page 155

are hazardous atmospheres, or extreme moisture. It can also be used outside in inclement weather or in magnetic dust locations. Vibrator is a one-piece design, has an integral striking plate that cannot separate and leak air. Unit is available in five piston sizes ranging from 1¼ to 4 inches. **National Air Vibrator Co.**, 2372 W. 7th St., Cleveland 13, Ohio.

Circle 461 on Page 155



Positioning System

Item 462

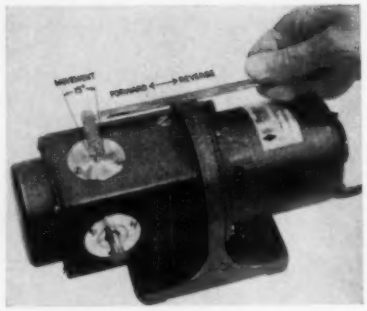
Instrument is suitable for short-run production operations such as punching, drilling, and inserting. To position the work, the operator sets dials which put instructions into the system. The dial settings control electrohydraulic servos which in turn position the tools performing the desired operation. A setup involving five different dimensions and three different repeat commands can be programmed by setting eight adjustment dials. If a variation in a dimension or sequence is required, it can be made by resetting the dials. Positioning speed is 0.2 second per basic motion; positioning accuracy is 1 part in 1000. **CDC Control Services Inc.**, 605 S. Warminster Rd., Hatboro, Pa.

Circle 462 on Page 155

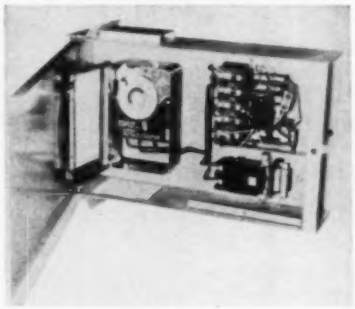
Variable Speed Drive

Item 463

Device is applicable on operations requiring automatic control. It is also suitable as an integrator for computers and weighing systems. Control forces could be the weight of the material, winding tension, hydraulic, or pneumatic pressure. The drive is a lever and push rod design. The speed control shaft moves through an arc of 15 degrees to shift from full speed forward to full speed backward in less than 1/10 second, without disengaging the load. Only two or three oz-in. on the control shaft is required to shift the drive. Output torque is constant and the efficiency is between 85 and 95 per cent. **Humphrey Products Div., Humphrey Inc.**, 3794 Rosecrans St., San Diego 10, Calif.



Circle 463 on Page 155



Oil Well Panel

Item 464

Unit provides precision pumping through automatic control, is designed for use with single-phase pumping units. Components in the oil well panel are: A time clock, motor starter, and short circuit protection device. The time clock is readily accessible, has adjustable settings over a 24-hour period. The magnetic motor starter is combined with a selector switch. When set on *Automatic* position, the time clock governs the operation of the motor starter according to preset time intervals. When set on *Hand* position, the control can be operated manually to inch or jog for any length of time without automatic control. Oil well panel is available in three models, can be used with pumping units rated up to

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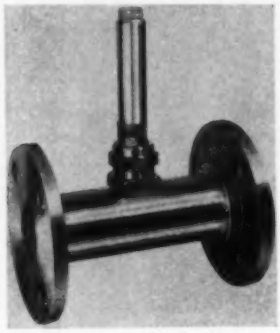
Pioneers in Pneumatic Timing

Circle 712 on Page 155

5 hp at 220 v, or 2 hp at 110 v, 60 cycle operation. **Federal Pacific Electric Co.**, 50 Paris St., Newark 1, N. J.

Circle 464 on Page 155

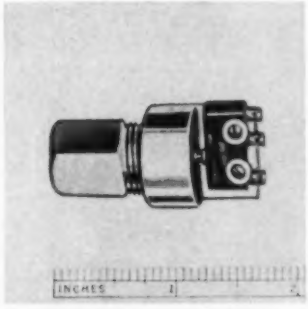


Flow Transducer

Item 465

Device automatically measures flow-rate and indicates the direction of flow. It is available to fit pipe sizes up to 4 inches. Electrical output of the flow transducer is applicable to indicators, recorders, or controllers. Accuracy is ½ per cent of full scale. Unit has no bearings or moving parts, is constructed of stainless steel. This composition makes it suitable for use with acids, caustics, and similar liquids. **Ramapo Instrument Co. Inc.**, 8 First St., Bloomingdale, N. J.

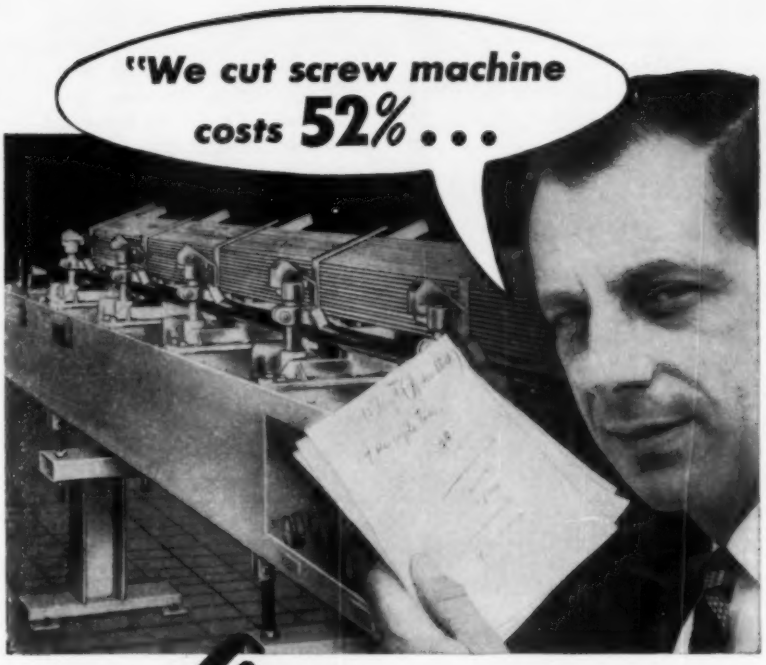
Circle 465 on Page 155



Pressure Switch

Item 466

Miniature unit is suitable for applications where weight and size are a factor. Switch weighs one ounce, is 1-23/32 inches long and 15/16 inch in diameter. It will operate from 25 to 1000 psi with an over pressure rating up to 3000 psi. Unit will operate in any position, has only one moving part. It is rated



WITH Lipe Automatic
Magazine Loading Bar Feeds

*says Production Supervisor J. H. Lindsey**

● When we were asked to cut costs to meet or beat competition five months ago, we decided to give the Lipe A.M.L. Bar Feed a try. We had heard that this feeding device enabled screw machines to deliver more than 90% of gross geared capacity. We had never done better than 75% with ours, even when new. In the first full week of bar feed operation, the machine to which the A.M.L. was attached *produced 146% more pieces than it had ever turned out before!*

● The A.M.L. fed stock *continuously*, with no repeat motion for feedouts . . . no down-time for changing feed-fingers, or for remnant disposal. There was no cutting air—and when you stop cutting air, you start cutting costs.

● As a result of this test, we installed an A.M.L. on every screw machine in the production line, with the exception of those we were able to eliminate because of the overall increase in output. When we come to install new machines, the A.M.L.'s will be there to develop *their* extra potential.

Write or Wire for a FREE Lipe Sales Engineering estimate of production increases, savings and amortization time of Lipe A.M.L. Bar Feeds in your production layout.

*Photographer's models and pseudonyms used to protect company identity and confidential information.

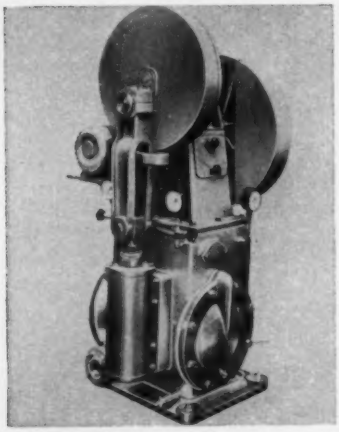
Lipe-ROLLWAY CORPORATION SYRACUSE 1, N. Y.

Manufacturers of Automotive Clutches and Machine Tools

Circle 713 on Page 155

for 5 amps, 240 v ac, single pole double throw. Inlet opening is ⅛ npt. **Alloy Bellows Inc.**, 18125 Roseland Rd., Cleveland 12, Ohio.

Circle 466 on Page 155



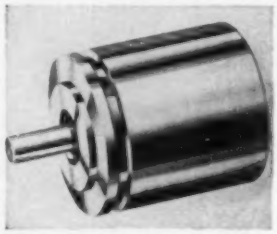
Diaphragm Type Pump

Item 467

Equipment is applicable in the ceramic, chemical, paint, and paper industries. It is designed to handle corrosive liquids such as acids, alkalines, or oils, and thick solutions containing materials such as clay, glaze, or paint. Diaphragm type pump is constructed with two sections—the piston case and the valve case. They are separated by a flexible diaphragm. A moving piston in a cylinder (this is powered by the pump motor) creates alternating pressure and vacuum on one side of the diaphragm. This motion is transferred to the media being pumped by means of the diaphragm. Spring-load ball check valves control the flow of liquid into and out of the pump.

The pump is available in single and double stage models. The single-acting pump model uses a single piston and provides an alternating pressure and suction on each stroke. The double-acting pump model has two diaphragms and two sets of valves with suction and pressure carried out simultaneously on each stroke. Maintenance or inspection of the diaphragm is accomplished by removing a bolted cover plate on the side of the pump. Unit can be furnished with either a standard belt drive or a totally enclosed gear motor drive. Pump is available in nine sizes with outputs ranging from 2.5 to 35 gpm at 115 psi. Maximum working pressures range from 14 to 230 psi. Drive motors range from ½ to 12 hp, depending on the output and pressure. **Schweitzer Equipment Co.**, 3764 Ridge Rd., Cleveland 9, Ohio.

Circle 467 on Page 155

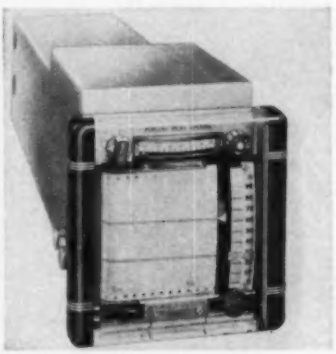


Servomotor

Item 468

Device features a low rotor inertia of 0.1 gm cm², a stall torque of 0.25 oz-in. to provide acceleration at stall of 170,000 rad/sec². Model 8 SM 420 is capable of continuous duty at 200 C total unit operating temperature. It can withstand 100G's shock and 30G's vibration to 2000 cycles. Fixed windings of the unit can operate from any 400-cycle source up to 57 v. Housing, shaft, and bearings are stainless steel, and all windings are encapsulated. A similar size 8 servomotor operated at 115 v, 400 cps is available. **Helipot, Div., Beckman Instruments Inc.**, Newport Beach, Calif.

Circle 468 on Page 155



Electronic Recorder

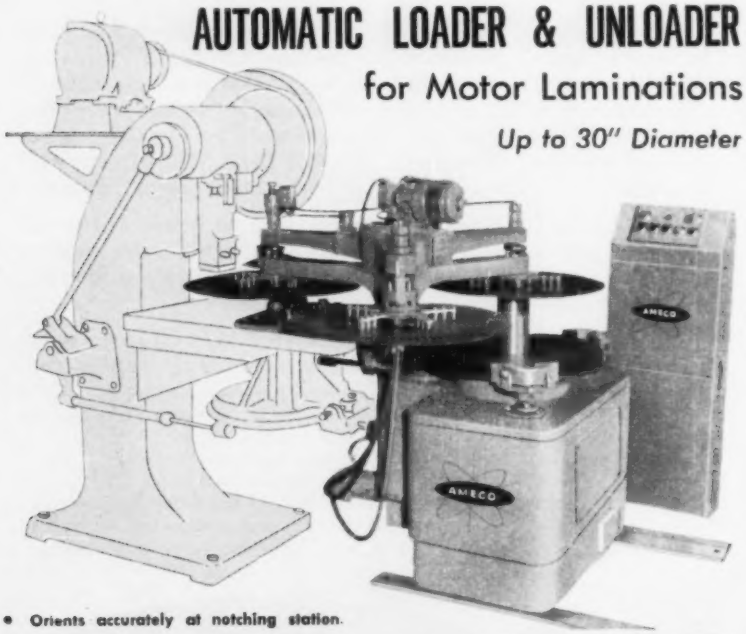
Item 469

Miniature two-pen instrument records two variables on a single chart. Recorder fits a 5-inch square panel cutout, is housed in 24-inch deep panels. Instrument sensitivity

AUTOMATIC LOADER & UNLOADER

for Motor Laminations

Up to 30" Diameter



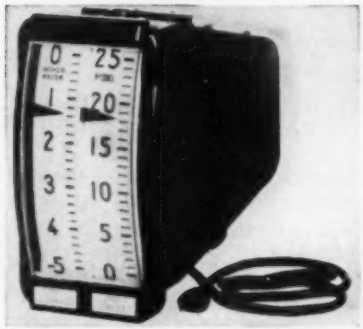
- Orients accurately at notching station.
- Loads and unloads in less than two seconds.
- Minimum weight on press.
- Load station moves out for reloading.
- Requires no operator except for reloading.

AUTOMATION MACHINES & EQUIPMENT CO., INC.
3130 WEST MILL ROAD MILWAUKEE 9, WISCONSIN

Circle 714 on Page 155

is 0.1 per cent or better, instrument accuracy is ±½ per cent of full scale. Unit contains two separate but identical signal amplifiers and pen-actuating mechanisms on a single chassis. Strip chart is driven by a dual sprocket, can be easily rewound to examine past records without breaking the chart continuity or tearing the chart. A special mechanical interlocking arrangement prevents the recorder from being removed from the case while power is on. All parts are interchangeable with parts from company's single-pen recorder. Swartwout Co., 18511 Euclid Ave., Cleveland 12, Ohio.

Circle 469 on Page 155



Multipointer Gage

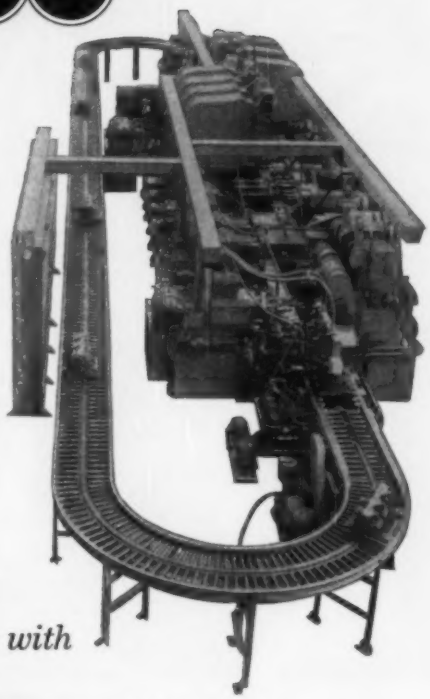
Item 470

Instrument has triple function. It can be used to measure, indicate, or transmit pressure, draft, differential, and level. Two indicators or one indicator and one transmitter (pneumatic or electric) can be mounted in a gage unit. Any number of gage units can be mounted adjacent to each other on a panel to provide multiple indications.

When used as a direct connected gage, each indicator section can contain a diaphragm element for draft, low pressure, or differential measurement; a bellows element for intermediate pressure or level measurement; or a bourdon tube for high pressure measurement. Ranges are from zero to 0.5 inch H_2O and zero to 5000 psig. When used as an indicating receiver each gage unit contains two pneumatic receiving bellows. The unit then indicates any two variables capable of being transmitted pneumatically over signal ranges of 3-15 or 3-27 psig. As an indicating transmitter,

E W B

computer-controlled conveying to automated production...



Buschman conveyor, integrated into this 23-station machine built by Avey Drilling for leading automotive parts manufacturer, assures continuing machining, checking, gauging and semi-assembly of 360 Automotive hydraulic steering pump bodies per hour.

you can save more with

Buschman *"Experience Engineered"*

WHEEL and ROLLER CONVEYORS

Now, more than ever before, dependable conveying is vital to profitable production. With intricate parts produced in seconds, there is no time for trouble.

That's why leading manufacturers insist on Buschman Wheel and Roller Conveyors for automated and semi-automated applications. Buschman offers low initial and operational costs, proved dependability, and creative engineering assistance for installation design.

Nearly ten million pieces each month are handled and shipped by this computer-controlled transfer station, equipped with Buschman Wheel & Roller Conveyors, in the new warehouse of a leading bearing producer.

Whatever your materials handling problem, Buschman can make low-cost production a reality. Write today for literature.

THE E. W. BUSCHMAN CO.
4551 Clifton Avenue, Cincinnati 32, Ohio

C-366-EWB

Circle 715 on Page 155

Part of extensive conveyor system serving production and shipping for prominent can manufacturer. Belt conveyors are assembled from pre-engineered units and equipped with Logan Adapto drives. Double decking lines conserve floor space.

Trimming costs to meet competition? The solution is mostly in your shop. With so much importance on the production end, it's small wonder that management is giving more and more attention to materials handling.

Logan Conveyors have been the key to greater savings in time, space and effort for large companies and small for over a half century. Production experts who specify Logan, expect and receive equipment designed for sound day-after-day performance.

Why not see what Logan can do for you? Write for more information or for a call from a qualified engineer.

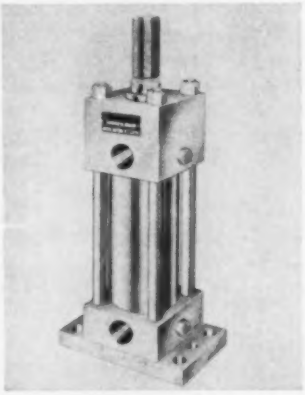
Write for your copy of the Logan TROLLEY CONVEYOR catalog

LOGAN CO., 218 CABEL ST., LOUISVILLE 6, KY.

Logan Conveyors

one section of the unit contains the measuring element while the second section contains a pneumatic or an electric transmitter. **Bailey Meter Co.**, 1050 Ivanhoe Rd., Cleveland 10, Ohio.

Circle 470 on Page 155

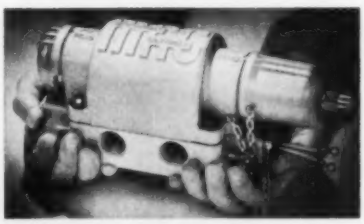


Air/Hydraulic Cylinder

Item 471

Device is a heavy-duty cylinder which is applicable on machine tools, presses, transfer machines, welding machinery, conveyors, and dies. Pressure ratings are 200 psi (air) and 1000 psi (hydraulic). Cylinder is constructed of honed seamless steel barrels, steel end plates, and heat treated low carbon, low alloy steel piston rods. All ferrous parts are rustproofed to resist corrosion. The piston and cartridge-retained rod seals are designed for operation at temperatures ranging from − 20 to 150 F. Unit is available in 9 bore sizes from 1½ to 8 inches. Five mounting styles are furnished. **S-P Mfg. Corp.**, 30201 Aurora Rd., Solon, Ohio.

Circle 471 on Page 155



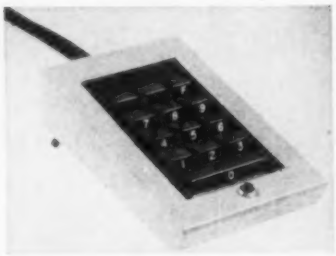
Circular Flow Valve

Item 472

Air valve features a double spool arrangement, is available in port

sizes from ½ through 1¼ inches. To operate the valve, the solenoid activates an inner spool, which in turn releases compressed air to energize the larger outer spool. Valve can be converted from a single-solenoid to a double by removing the retainer head and inserting a covered solenoid assembly. For maintenance purposes, a clamp ring permits simple removal of the solenoid cover and assembly. Current ratings are 0.8 amp inrush and 0.125 amp holding at 115 v, 60 cycles. **Mechanical Air Controls Inc.**, 10030 Capital, Oak Park, Detroit 36, Mich.

Circle 472 on Page 155



Decimal Keyboard

Item 473

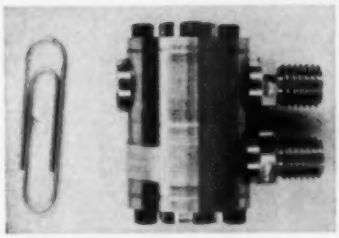
Unit is designed to provide manual digital input to devices such as plotters, computers, paper-tape preparation units, and control equipment. Model 410 contains 10 decimal and three optional assignment keys. Each of the key-operated, single pole, double throw switches has three taper pin terminated leads. Cable is 3 feet long, includes leads for the power-indicating light at the base of the keyboard. Unit is rated for 5 amp, 125 v ac; 2 amp, 30 v dc. **Electro Data, Div., Burroughs Corp.**, 460 Sierra Madre Villa, Pasadena, Calif.

Circle 473 on Page 155

Pressure Transducer

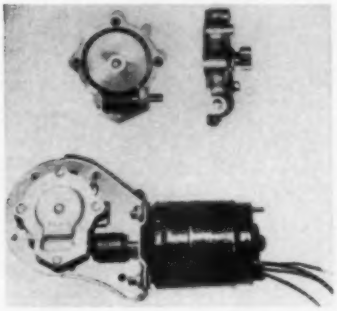
Item 474

Adjustable range pressure transducer can translate gas or liquid pressure to proportional electrical signals. It is suitable for use in recording or control systems or wherever a small size instrument with high response rate is required. Model P-501 is a double-coil variable reluctance type with a flat diaphragm as the pressure sensing



element. Transducer features a complete interchangeability of one transducer to another of any range with constant output. Unit has outputs of 0.3 v per volt over a carrier frequency range from 400 cps to 70 kc, allowing operation with all standard telemetering channels. Another feature is its resistance to severe environmental conditions. **Yuba Consolidated Industries Inc.**, 351 California St., San Francisco, Calif.

Circle 474 on Page 155



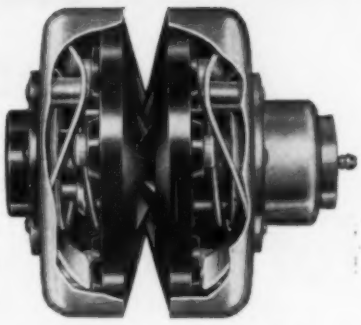
Power Transmitter

Item 475

Self-locking worm gear power transmitter is capable of reducing motor revolutions and increasing torque. It is suitable for any application in which electrical power must be converted to rotary or straight-line mechanical actuation. Transmitter is designed for use in rack and pinion, gear and pinion, or friction drive operations. Unit is available with two transmission ratios; 52:1 and 27.5:1, with either a six or eight-tooth pinion. Input shaft is ¼-inch in diameter and 3/16-inch across the flats. The output is at right angles to the motor shaft input, permitting simple installation. Unit is rated for 1/9 hp at 2000 rpm, 1/6 hp at 3000 rpm, or 1/5 hp at 4000 rpm. **Huppower Div., Hupp Corp.**, 7450 Melville Ave., Detroit 17, Mich.

Circle 475 on Page 155

Hi-Lo Load-O-Matic Control Eliminates Pulley Slow Down



Hi-Lo Variable Speed Pulleys positively maintain the desired speed ratio over a wide range of load variation by means of an exclusive cam and cam follower assembly. This means:

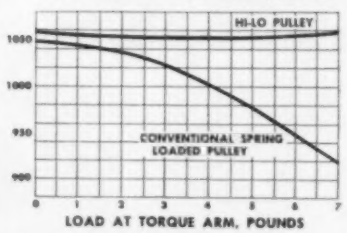
Pulley speed is independent of load and load changes. "Drag" is eliminated and high shock absorbency provided.

Pulleys do not compress belt due to spring pressure. Springs are not driving members. They act only to keep pulley faces in contact with belt.

Pulleys automatically regulate belt tension. Because of the cam assembly, belt is never under more tension than required by the load.

Double cams maintain constant belt alignment.

HI-LO PULLEYS COMPARED TO OTHER VARIABLE SPEED PULLEYS



PLUS THESE OTHER FEATURES:

- Smaller in size than comparable units.
- Quickly and easily installed.
- Replaceable face assemblies drastically cut repair and replacement costs.
- Available in sizes from .5 to 5 hp., ratios to 2.5/1 (single pulley) 6.25/1 (double pulley).

Request details and prices. Ask for Bulletin A-458.

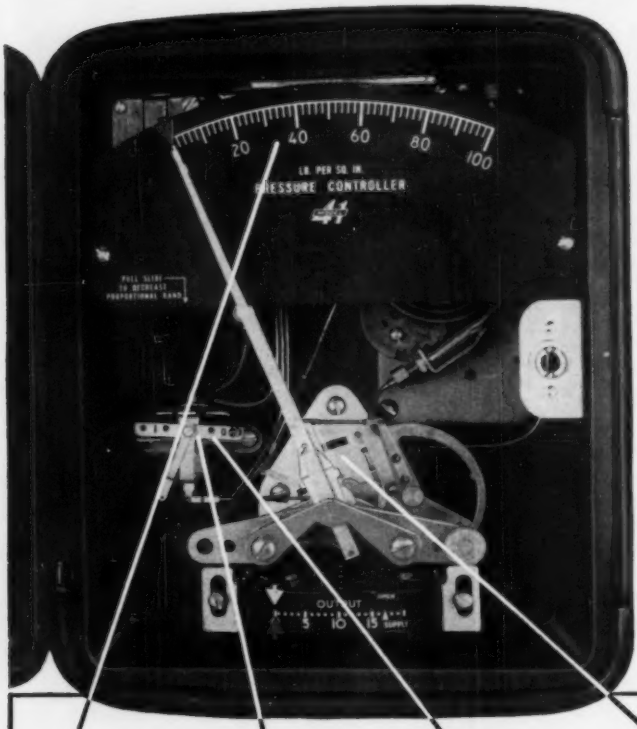
Manufactured By HI-LO MANUFACTURING COMPANY

Nationally Distributed By LOVEJOY FLEXIBLE COUPLING COMPANY 4956-H W. Lake St. Chicago 44, Ill.

Circle 717 on Page 155

Now!
An even BETTER Controller for simple processes!

...the improved Foxboro M/41A Indicating controller



Here's the Foxboro Pneumatic Controller that proved itself in thousands of successful applications throughout industry! Now, with brand new design features, it's better than ever.

The M/41A Controller offers a sharp, fast on-off action, or smooth proportional control action easily adjustable up to 50%. It employs the famous Model 40 controller movement — free from backlash, lost motion, and friction. This is a rugged, low-cost, compact controller using standard M/40 parts *throughout* . . . easy to get at . . . easy to service.

For control of simple processes—temperature, pressure, liquid level, or humidity — it will pay you to investigate the convenience and the precise, reliable performance of the Foxboro M/41A Indicating Controller. Write for Bulletin 5A-13A.

New Design Features

- Longer Scale — 5" effective length.
- Snappy "On-Off" Control Action on measurement change of only ⅛ of 1% scale.
- Alternate Proportional Action adjustable from ¼ of 1% to 25%.
- "Permaligned" Precision Controller Movement — Exclusive Self-Aligning Ball-Linkage—Non-Backlash Vernier Index Drive
- Simple Rugged Construction—All Parts Easily Accessible

THE FOXBORO COMPANY, 1211 NORFOLK STREET, FOXBORO, MASS., U. S. A.

FOXBORO REG. U. S. PAT. OFF. **INDICATING CONTROLLERS**

Circle 718 on Page 155

AUTOMATION abstracts

GROWTH OF TECHNOLOGY IN TRANSISTOR MANUFACTURE

By J. E. GENTHER
Asst. Supt., Varistor Engineering
Western Electric Co.
Allentown, Pa.

WHEN Western Electric Co. started to manufacture transistors in 1951 it was faced with a new technology and a new set of manufacturing problems. The manufacturing engineer's first view of the transistor was one of excitement and anticipation. As he studied the original point-contact transistor, he saw a product simple in structure, rugged, and enclosed in plastic so that it would lend itself easily to mass production. However, it did not turn out quite that way. Problems were soon encountered in the areas of reliability, reproducibility, and range of performance.

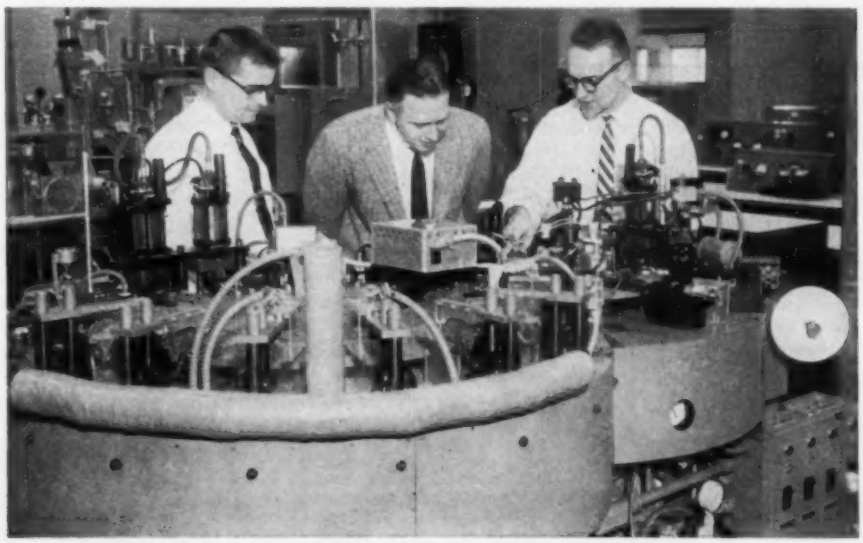
Some of the first transistors were tested to determine whether or not their electrical characteristics would change under conditions of wide temperature and humidity ranges. They did. They were not reliable. Neither were they completely reproducible. It seemed that no two point-contact transistors behaved alike. In addition, not nearly enough transistors produced by the process met exacting Bell System requirements.

These problems and other experiences were fed back to members of an "organized creative technology" team. As a result, point-contact transistors ultimately became manufacturable. Point-contact transistors in use in card translators since 1952 have a reliability history of 1 million socket-hours per failure.

The grown-junction transistor announced in 1952 was of considerable interest for several reasons. In the first place, it had new ranges of parameter properties and extended the application possibilities. In addition, grown junctions, which were understood and reasonably controlled, did not require artful forming. Finally, the manufacturing engineeer was able to visualize an electronic product whose properties could be determined by test at an early stage of the manufacturing process.

Advent of the grown-junction transistor required that a new technology be learned, involving a whole new set of processes, tests, and even a new language in which "junction" was the common term. An operator could learn forming techniques in a few days, but it took engineers months to learn to grow single crystals with doped layers a thousandth of an inch thick between junctions with the precision and control needed for this work. As grown-junction devices were put into manufacture, changes were made which improved them and their manufacturing processes. Nor were grown-junction transistors without their early reliability problems, which necessitated many changes and adoptions of new processes. As their extreme surface sensitivity was discovered, the simple concept of plastic encasement was dropped in favor of a vacuum-tight, metal-to-glass sealed container.

Working together, Western Electric and Bell Laboratories engineers solved these and many other problems.



Machine for assembling transistors automatically is evidence of maturing manufacturing technology in semiconductor field. Production of low-cost transistors will require development of automatic equipment for all phases of manufacture.

They developed electroetching, thus making unnecessary the costly solutions of hydrofluoric, nitric, and acetic acids which could be hazardous to both man and machine. Automatic bonding of the base contact was visualized, and a machine was built by the Laboratories to establish that this could be done. A round can design was introduced in place of the initial oval design as an aid to ultimate automatic manufacture. A machine for making these devices was planned and built. In spite of problems with reproducibility and range of performance, which affects demand, the machine produces units, and automatic semiconductor production is a step on the way to reality.

The grown-junction transistor has an excellent field record in an application where it is operating well within its range of performance. In hard-of-hearing set amplifiers, only one unit in 70,000 has failed in two years of operation.

Continuing Developments

In 1955 a new transistor technology, the alloy process, was introduced to meet the needs of systems employing digital techniques for which the grown-junction transistor was not suitable. As manufacturing experience was gained on these devices, it became clear that the alloy technology processes, though involved, were capable of the requirements requested of them. It was soon found that these alloy transistors could be process-tested at many points during manufacture and that controls could be initiated which would make the devices reproducible and reliable.

Applying what was learned from earlier transistor production, a process has been developed to load alloying jigs semiautomatically. As an alternative technique, alloying pellets are also being attached by a rapid "tacking" operation. Cumbersome basewafer mounting brackets have been eliminated to produce a simple structure capable of handling more power than its prototype. New techniques have been developed for making electrode contacts, to replace a tedious hand process.

In the meantime, development engineers have introduced junction formation by the diffusion process. This appears as an additional technology to be learned and controlled, but with an encouraging and stabilizing note: It suggests common material, common technology, and control through understanding and measurement.

The many demands of semiconductor technologies have been challenging to the manufacturing engineer. He has had to strike a balance between the present—to provide adequate facilities for existing techniques—and the future—to be prepared for the new and better way in this rapidly evolving field. Above all, he has had to reconcile new techniques with cost and scheduling requirements. It is significant that in ten years the transistor has been developed to the point where it can compete performance and cost-wise in many applications with its 42-year old competitor, the vacuum tube.

From an article entitled "Transistor Manufacture" which appeared in Bell Laboratories Record, *Vol.* 36, *No.* 6, *June,* 1958.

PACKAGING AT HIGH SPEEDS

By WICKLIFFE JONES
President
R. A. Jones & Co. Inc.
Cincinnati, Ohio

DEVELOPMENT of packaging machines capable of sustained operation at cartoning rates of 300 to 400 per minute has required fundamental re-engineering, from the design of the leveling screws on up. Starting with the motor, we have nearly doubled the horsepower. Perhaps the most costly, but most needed, improvement has been a greatly beefed-up packaging machine frame. As one designer said, the ideal frame would be a solid chunk of metal with a few cavities routed out to receive the working parts. At these speeds, you need not only strength to resist deflection, but mass to absorb vibration.

Equally inadequate on the older machines was the power train. Shafts have been increased in diameter, and virtually all important frame bearings are now of the antifriction type, usually sealed. Gears have been increased in size and precision. Hardened teeth and ground bores are common on gears with high tooth loads. Wherever a miter gear, crank, eccentric, or cam is attached to a shaft, the older practices of pinning or keying are scarcely reliable. One of the most valuable improvements has been the use of split hubs that clamp the gear or other part around the key. The extra grip provides added security that is really worthwhile.

Machine Dynamics a Factor

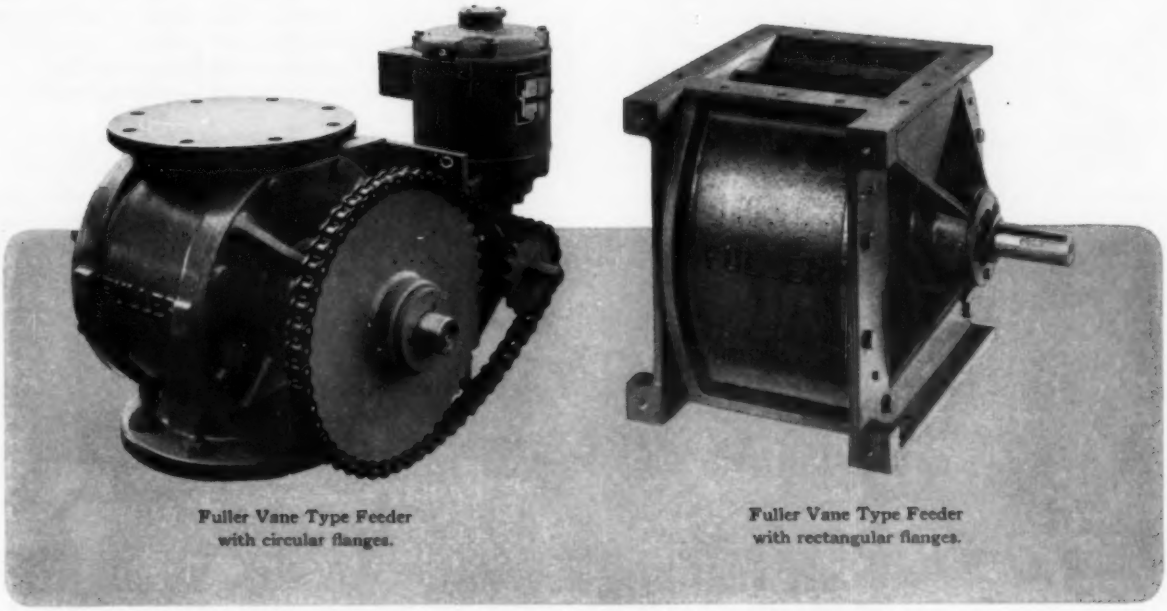
Beefing up the frame and strengthening the power train, while basic, were not in themselves enough. We have also had to reduce the machine effort required by eliminating awkward and jerky motions. The new high-tensile aluminum alloys are proving a splendid material for reducing the weight of reciprocating parts. On other parts we are finding many uses for ductile iron which can be economically cast and machined, yet whose tensile strength approaches that of steel. The use of steel weldments for certain high speed levers has also proved fruitful in achieving strength with reduced weight. It is no longer feasible to solve the problem of the weak lever by making it heavier; that defeats the purpose. Today, we have to go to the added time and expense of calculating the stresses as closely as possible and designing accordingly.

Sealed Bearings Important

With a machine running continuously at 300 per minute, there is little or no time for a mechanic to get in to lubricate it every 3 or 4 hours. While one-shot lubricating systems are thoroughly reliable and usually justified for multi-shift operating, the more basic solution has been an insistence that all important bearings be of a design that includes a lubricant reservoir. Sealed antifriction bearings and spherical self-aligning rod ends comfortably meet these standards. Also fitting into this category are antifriction ball bushings for carrying reciprocating parts. Grease seals at the ends of these components exclude carton lint and

Fuller Feeders
Keep Conveyors Flowing Freely

. . . whether the load is a few pounds a minute or many tons an hour



Fuller Vane Type Feeder with circular flanges.

Fuller Vane Type Feeder with rectangular flanges.

Fuller Vane Type Feeders assure you of dependable handling of dry, pulverized and granular materials. They're available in capacity ranges to meet all normal plant requirements, and are built with circular or rectangular outlets. Check these Fuller cost-saving features . . .

Extra-rugged construction. Heavy, cast iron body walls and headplates add rigidity, longer life. Stainless or other metals can be used where sanitary or corrosion requirements demand their use.

Sealed bearings are equipped with Alemite fittings for ease of lubrication and long life. Abrasive particles can't enter, maintenance is cut.

Make effective air locks. Fuller Vane Type Feeders can be used as air locks for pressure differentials up to 3½ lbs.

Stuffing boxes and ball bearings for vacuum, low-pressure and general applications.

And, where extreme volumetric accuracy without pulsation is needed, there's a line of Fuller Roll Type Feeders. For full details on Fuller Feeders write for Bulletin.

1306
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Circle 749 on Page 155

other foreign materials. Their reservoirs hold enough lubricant to allow operating periods of several days to a week without attention.

We also find that chains need more care than we had expected. Hardened steel chain tracks and continuous oiling of the main transport chains are necessary.

Where it was formerly safe to slap the clutch lever and let the cartoner reach its full speed of 150 per minute in a fraction of a second, such a start at 300 per minute is quite a shock to the machine and to the products carried in its conveyors. Fortunately, several means of gentle starting are available. One of the simplest is a 3600 rpm ac motor which draws only a third of the current at starting as a 1750 rpm motor. You can then de-energize the motor whenever the clutch is de-energized, and can safely start up under load with smooth acceleration.

While we go to pains to achieve a gentle start, we can't afford to be so considerate of the machine in stopping. If you have a jam, you can't tolerate the normal coasting of 2 or 3 cycles. Dynamic braking or a separate electrical brake are both good stopping means.

Quick stopping suggests another subject which requires careful thought in planning a 300-per-minute line. Unless so much floor space is available that the length of connecting conveyors between machines can be doubled, the preceding machines must be stopped quickly when the cartoner is shut down. The practice of having operators pull the product off when one machine is stopped and later putting it back on is scarcely practical at 300 per minute—everything is moving too fast. If the line is particularly close-coupled, the operator frequently cannot observe the fact that the line is filling up; the preceding machines must be stopped automatically. Since one justification for high speed lines is floor-space savings, longer connecting conveyors or surge tables to act as reservoirs are becoming less and less an answer.

Machine Lines Feasible

With this realization, there become fewer objections to mechanically or electrically coupling two, three, or more machines in a line. The advantage is single control, and the fact that the bottles or other products are usually kept in timed relation from one machine to the next, so that losing or maintaining a prime between individual machines is not a problem. Also, the remote control, variable-speed drive is proving a partial answer as it enables an operator to quickly adjust a particular machine according to the flow of material to it, thus avoiding stops, starts, and exhaustion of prime.

Several years' actual industrial experience shows that under proper conditions, products can be cartoned at 300 or more per minute with no more maintenance or downtime than was encountered with older machines at 120 to 150 per minute. But it is certainly true that less time is available to perform the needed maintenance at 300 than at 150. If a part gets loose, it won't last very long at 300. If maintenance is sloppy now

dependable machine support . . .
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an

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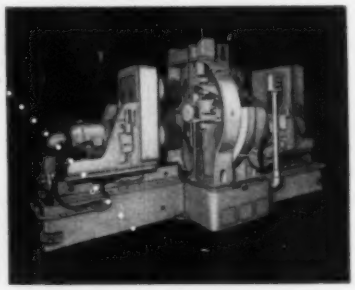

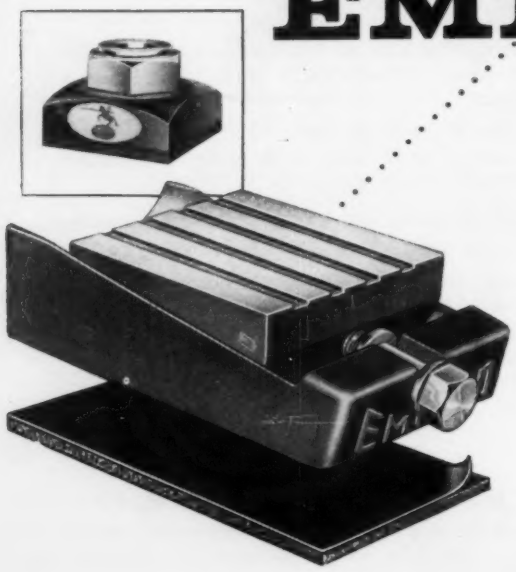

Dependable, easy-to-adjust Empco Leveling Jacks provide a solid foundation for machine tools, large surface plates, automation lines, tool room and production equipment of all types. Periodic leveling? It's a matter of seconds! Simply turn hex-screws . . . your machine is set level . . . kept level!

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Support? Up to 10 tons each! Available in six styles, 25 models . . . an Empco Jack to meet every job requirement. Set your machines level, keep them level. Reduce machining costs with Empco Jacks!

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Manufacturers of Automatic Production Machines, Fixtures, Machine Parts

at 150 per minute, real trouble will be experienced at 300. On the other hand, an alert, conscientious maintenance force could maintain the better-designed high speed equipment at less cost than that for older, slower machines.

Somewhere in the economic appraisal of a high speed packaging line, one must ask about price. How much more does it cost? For the simpler packaging task of a single type bottle, tin, or tube, the answer is encouraging. Compared with a conventional 120 to 150 machine a 300 per minute cartoner will probably cost only 10 to 15 per cent more. Of course, for one-shot lubrication, remote control, variable speed drive, etc.—features which are frequently very functional and justified, but not absolutely needed—the cost will increase another 10 per cent.

In summary, speeds of 200 to 400 per minute are here. Under proper conditions they are possible, practical, and profitable. Present engineering, production, and maintenance staffs are adequate. All that is needed is a continuation, and an intensification, of the efforts that brought efficiency at slower operating rates.

From a paper entitled "Machinery Problems Introduced by Today's High Speeds" presented under the sponsorship of the Packaging Institute at the 1958 *Packaging Machinery and Materials Exposition, Atlantic City, N. J., March* 1958.

GAGING IN MANUFACTURE

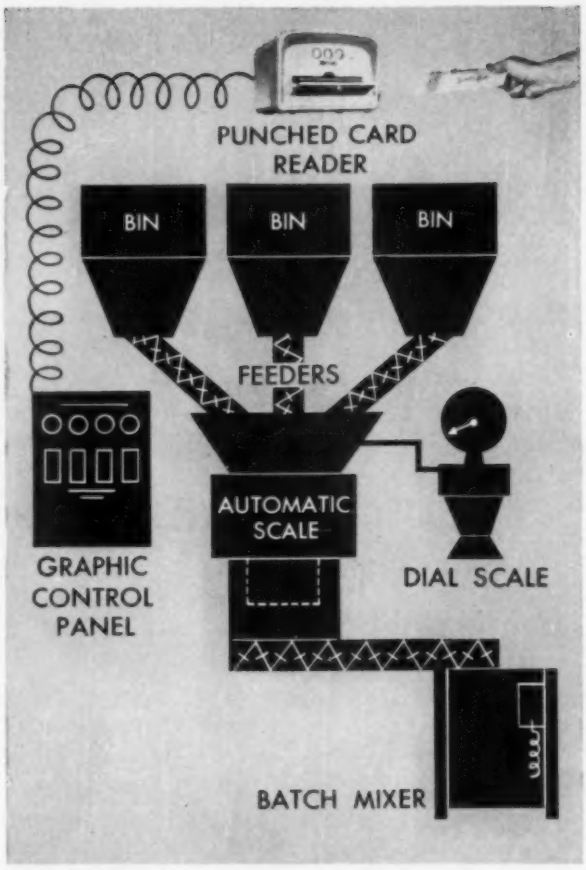
By LOUIS O. HEINOLD JR.
Federal Products Corp.
Providence, R. I.

INSPECTION, traditionally a "post-mortem" operation, is becoming a part of many manufacturing processes. Gages are now being placed on or in productive machines, at their exit points, and adjacent to them. The aim is to effect cost reductions by halting or modifying the process before defective parts are produced.

In-process gages are useful in controlling piece-to-piece variations that occur in machine tools. These variations are caused by such factors as looseness between movable elements and deflections of the machine members and tools.

A grinding operation in the production of small compressor crankshafts furnishes an excellent example of the economies realizable through use of in-process gaging to control piece-to-piece variations. Before control gages were installed, two operators and two machines produced 1344 pieces in 8 hours at a unit cost of $0.03585. The grinders were then equipped with in-process gages and rearranged so they could be tended by one operator. Although output of the new setup increased to only 1386 pieces per hour, the unit cost was cut to $0.01526. This 56 per cent savings in cost per piece paid for the gaging installation in 60 days. Additional benefits such as reduction of scrap and product quality improvement were also realized.

Post-process gaging can be applied at the exit of a machine to detect trend variations and stop the ma-



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Circle 722 on Page 155

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Small size high performance air and hydraulic valves for manifold mounting

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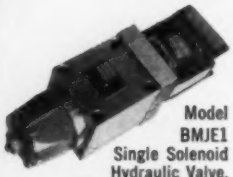
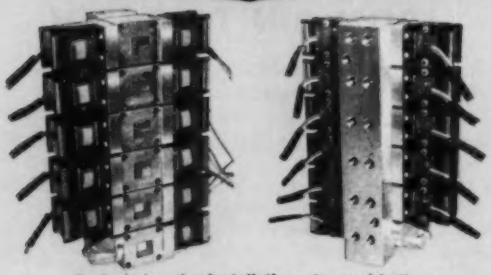
Model BMJE2 Double Solenoid Air Valve. Size 2" wide x 2¼" high x 8½" long. Top and bottom views shown.



Model BMJE1 Single Solenoid Hydraulic Valve. Size 2" wide x 2¼" high x 7¼" long.

Provide extremely compact multiple valve installation with common subplate for automation controls on specialized machine tools and other production equipment.



Typical six valve installation—top and bottom views shown. Block is 12½" long.

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- Two, three or four way.
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- Nominal ¼" size

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chine when parts approach their tolerance limits. Trend, or drift, variations occur as a result of factors such as ambient temperature changes, buildup of heat evolved during cutting, and tool wear. By use of post-process gaging, changes in the size of a product can be automatically analyzed statistically in the true quality control fashion. For example, gaging equipment that measures the product directly after it leaves the producing machine can be set up to have four limits of control. Two of these limits are the tolerance limits by which parts are sorted into "good" and "bad" categories. The other two limits are inner control limits, sometimes designated "approaching undersize" and "approaching oversize." These limits are energized to stop the machine only if a predetermined number of pieces in sequence exceeds the limits.

It is not necessary to have an automatic process to realize the gains obtainable from process gaging. For example, virtually any type of machine can be fitted with visual-type gages. The dials of these instruments can be marked with suitable control limits, and machine corrections made when a series of parts exceeds one of the limits. It is most important that the machine operator be educated in such a technique. It is pointless to have him go through the motions of measuring without understanding its significance. He must be made a partner in the new setup, since his co-operation and understanding are fundamental to its success.

Design of gages for use in manufacturing processes must stress reliability—often such devices are asked to operate in severe environmental conditions, with very little maintenance, and that performed by relatively unskilled repairmen. Stability, ruggedness, accuracy, and ease of maintenance are necessary qualities of such instruments. Reliability tests might well be made a part of the user's purchase specification.

From a paper entitled "Cost Reduction Through Control Gaging" presented at the 12th Annual Convention of the ASQC, Boston, May 1958.

EVALUATING AUTOMATION PROJECTS

By JOHN G. KNEILING
Office of Theodore J. Kauffeld
Consulting Engineer
New York, N. Y.

MANAGEMENT acceptance of a proposal to automate usually requires that an economic advantage be shown for the proposed project over existing or alternate methods. Findings are usually set forth in a report. Practical business considerations must prevail in all phases of the study; technical data are used to supplement a ruling.

Although labor costs are usually a prime consideration, other factors—service requirements, availability of capital, etc.—may influence the decision. Author suggests a thirteen-point procedure for conducting a feasibility study for an automation project:

1. Examine the process as it exists or is proposed without automation.

Circle 720 on Page 155

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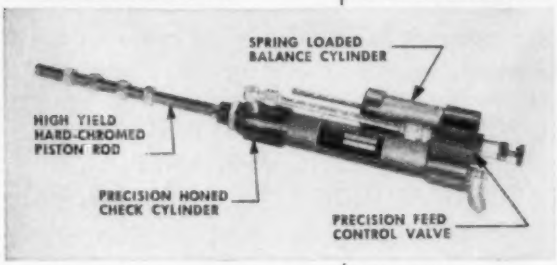
Self-Contained HYDRAULIC POWER CHECK . . .

for smooth, precise feed control of air cylinders and machines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Circle 736 on Page 155

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The New CLEMATIC F BRAKE MOTOR Simplifies Machine starting and stopping

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Circle 737 on Page 155

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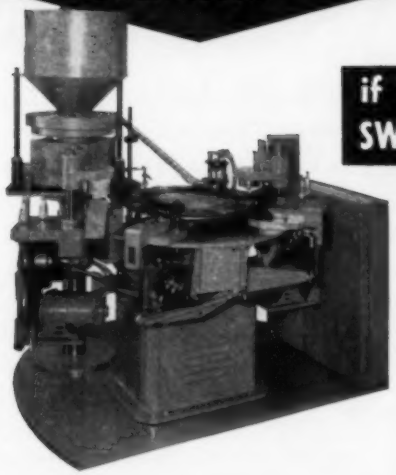

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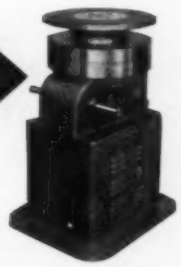

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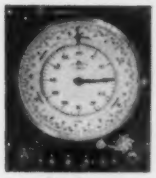

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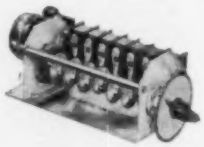

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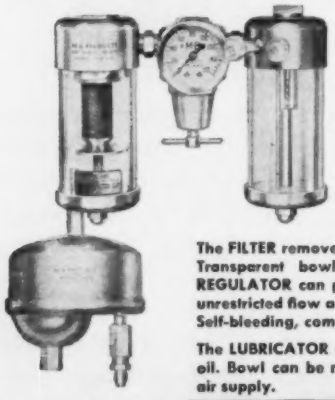

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Circle 727 on Page 155

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- Every CON-CHEK hardened and ground, with chromed pilot and hardened gage pins.
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Circle 728 on Page 155

Circle 726 on Page 155

2. Separate the process into elements, seeking the smallest practical "packages." Each "package" must be capable of being automated without neglecting any functions.

3. For each "package," verify that there is at least one practical way that the function can be performed automatically.

4. For each "package" selected, check the possibilities for partial automation. If such possibilities are found, consider revising the boundaries of the "packages."

5. Estimate the total cost of jobs that can be eliminated.

6. Estimate total labor, maintenance, and operating costs involved in the proposed system.

7. Estimate capital required to automate. List engineering, equipment, and installation costs separately.

8. Estimate salvage values that may be obtainable.

9. Compare net investment (first cost of new equipment less salvage value of old equipment) with net direct labor savings (labor cost less cost of jobs remaining and created).

10. Refine the cost comparison by listing money values of safety and product quality improvements, material cost reductions, etc.

11. Calculate ratio of net savings to investment. Include, it practical, a statement of probable range of error of this ratio.

12. Carry out this process for each alternate proposal.

13. Prepare a report summarizing the findings. The function of the report usually is to inform, seldom to recommend.

From a paper entitled "Economic Evaluation of Automation Projects" presented at the 13th Annual Instrument-Automation Conference of the ISA, Philadelphia, Sept. 1958.

ELECTRICAL CONNECTION RELIABILITY

By W. F. BONWITT and H. P. DUPRE
Omaton Div., Burndy Corp.
Norwalk, Conn.

CRIMPED electrical connections must satisfy two requirements—electrical conductivity and mechanical strength. This paper discusses factors that contribute to reliability of such connections and indicates testing methods that can be applied to assure control of quality. Importance of proper shape of the joint is stressed. This must be such as to meet electrical and mechanical requirements and be manufacturable on manual or automatic equipment. Charts are shown that compare electrical conductivity and pull-out strength to degree of deformation of test joints. These charts are useful in determining optimum nominal shape of joint and to show effects of tool wear on quality of connection. Comparisons are drawn between crimped and soldered connections, and relative economics are discussed.

From a paper entitled "Designing Reliability Into Electrical Connections" prepared for discussion at the Third EIA Conference on Reliable Electrical Connections, Dallas, Dec. 1958.

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standard components!

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conveyor
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handling costs
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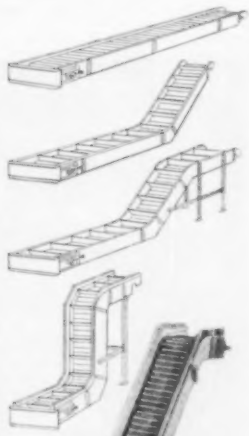

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Increase Production - Cut Costs

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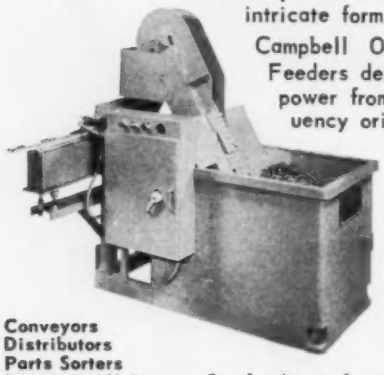

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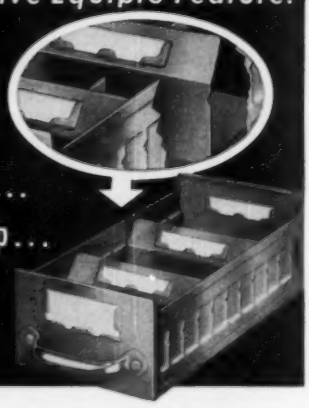

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Circle 731 on Page 155

AUTOMATION

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AUTOMATIC CONTROL: PRINCIPLES AND PRACTICE

By Werner G. Holzbock, chief engineer, GPE Controls Inc., 258 pages, 6 by 9 inches, illustrated, clothbound, published by Reinhold Publishing Corp., New York; available from AUTOMATION; *$7.50 postpaid.*

This book discusses automatic control without use of advanced mathematics. Characteristics and responses of various types of systems are noted. Responses and adjustments of major types of controllers, their mechanical and electrical components, and balancing and computing arrangements, are also described. Other chapters discuss measuring elements, final control elements, and specific industrial installations in various fields.

QUEUES, INVENTORIES, AND MAINTENANCE

By Philip M. Morse, director, M.I.T. Computation Center; 202 pages, 5¾ by 9 inches, clothbound, published by John Wiley & Sons Inc., New York; available from AUTOMATION; *$6.50 postpaid.*

This book is the first in a series of publications planned under the auspices of the Operations Research Society of America. It is an introduction to waiting line theory and will be followed by publication of extensive tables for waiting line computations. Applications discussed include problems in machine maintenance and inventory control.

Industrial Publications

STATIC CONTROL APPLICATION—3rd ED.

Paperbound, 152 pages, 8½ by 11 inches, illustrated; available from General Electric Co., Schenectady 5, N. Y.; $5.00.

New edition was prepared by General Purpose Control Dept. to explain static control for general purpose industrial use. Logic concept and fundamentals of static control are explained in simplified manner and mechanical construction of static units is described and illustrated. Material is included on circuit design, panel layout, system check-out, other application considerations, and ordering information.

PERMANENT MAGNET HANDBOOK

Loose-leaf binding, 375 pages, 6 by 9 inches, illustrated; available from Crucible Steel Co. of America, P. O. Box 2518, Pittsburgh 30, Pa.; $10.00.

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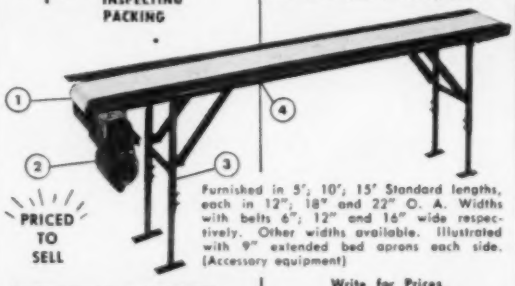

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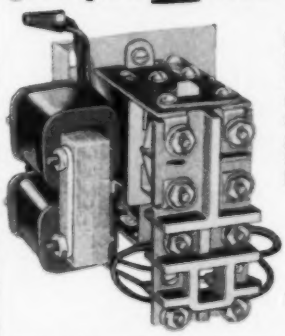

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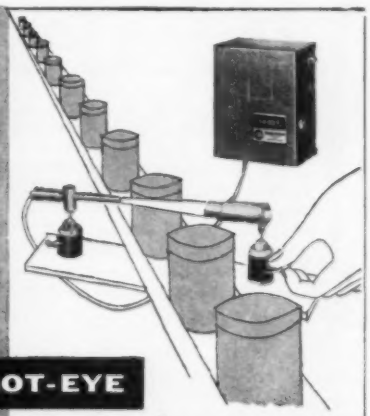

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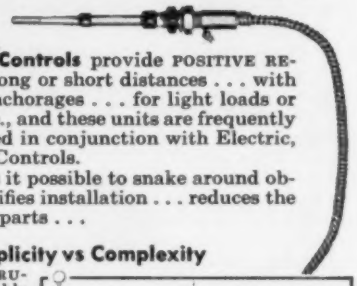

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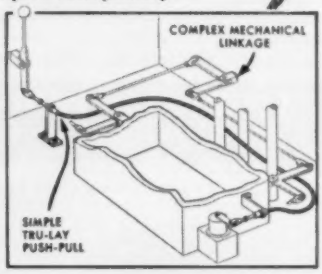

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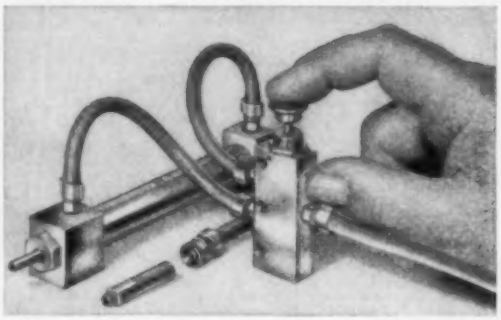

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CUMULATIVE EDITORIAL INDEX

Including six issues. Number preceding the hyphen is month of issue; those following are page numbers in that issue.

A

Accumulating trains of cartons, 10-66
Actuators, pneumatic, 9-66
Adhesive bonding, 8-49
Allen, J. V.
  Producing Core Assemblies, 10-59
Analog positioning system, 10-65
Anderson, R. H.
  Modular Electronic Assembly, 9-83
Anodizing, 9-88
Armstrong, N. E.
  Automatic Techniques of Oil and Gas Production, 8-57
Aronson, T. F.
  Producing Core Assemblies, 10-59
Assembly,
  automated, 10-59; 11-82, 135
  automobiles, 9-37
  by diecasting, 9-79
  electronic components, 9-83
  glass to metal, 9-86
  gravity conveyors, 6-40
  of darts, problem, 6-134; 9-157
  of stoppers to bottles, 11-150
  typewriters, 7-55
Automation,
  and labor, 8-115
  and management, 8-115; 11-16
  and the community, 6-10
  and the economy, 7-12; 8-9, 115; 9-10; 11-10
  developing manufacturing engineers, 10-50
  do-it-yourself, 10-43
  for small-lot producers, 7-53; 8-115; 10-10
  in coal industry, 6-12
  in food industry, 8-12
  in petroleum industry, 8-57
  in railroads, 6-9
  in refineries, 7-109
  in textile industry, 7-11
  numerically controlled machine tool system, 6-34
  organization, 10-44
  philosophy, 6-121
  planning for, 6-121; 8-12
  Third Conference, 11-12
  trends in, 6-121; 8-115; 11-10
Automobile,
  glass manufacture, 8-25
  parts manufacture, 9-74, 144; 10-82; 11-82

B

Bakery operations, 8-12
Baking, carbon brick, 8-48
Balance checking, 8-62; 9-144
Batch weighing, 7-34
Binding paper rolls, 6-49
Bolz, E. W.
  Manufacturing Engineering, 10-44
  Selling Solutions, edit., 11-41
Boring machine control, 9-50
Browning, E. H.
  Strip Mill Uses Automatic Programmed Control, 6-64
Building-block controls, 11-75
Bulk containers, 10-55
Bulk handling, 7-34

C

Canceling letters, 11-55
Card controlled, jig borer, 10-79
Casting production, 8-38; 9-14
Center of gravity determination, 8-62
Centralized control, 6-9
Chope, W. E.
  Using Data Reduction for Continuous Processes, 11-42
Circuits,
  electronic simplification, 9-83
  industrial control, 9-152
  pneumatic, 7-67
Clamping mechanism, 7-65
Closed loop control, 9-48
Coating sheet metal, 9-62
Cocks, E. H.
  Considerations in Selecting Automatic Painting Equipment, 8-66
Code directory unit, 11-57
Coding letters, 11-57
Cold rolling steel, 11-42
Color coding, 9-81
Components, electronic data processing, 9-75
Computers,
  analog, 7-14
  for graphs, 10-16
  for process control, 11-10, 37
  for relay design, 10-40
  oil and gas production, 8-57
Conference, third automation, 11-12
Continuous weighing, 7-36
Contour machining, 7-28
Contouring control, 7-57; 8-76
Controls,
  air motors, 9-150
  anodizing machine, 9-88
  building blocks, 6-34; 11-75
  by computers, 8-57
  characteristics, 9-48
  computers, 11-37
  contouring, 7-57
  dynamometer, 11-31
  electrohydraulic, 6-69; 9-71; 10-59
  electropneumatic, 9-66; 10-82
  fuel production, 8-16
  furnace, 8-10; 9-66
  gaging, 10-69
  grinding machine, 10-67
  handbook of, 9-152
  heat treating, 8-64
  heating & air conditioning, 9-10
  hydraulic drive, 7-52
  length, 8-55
  machine tools, 10-75, 128
  maintenance system, 7-14
  numerical, 7-25, 57; 10-9, 75; 11-76
  numerical controlled machine tools, 6-34; 9-12
  of gas compressors, 8-57
  of material level, 8-70
  of pumps, 8-10
  oil and gas production, 8-57
  pipeline surge, 7-14
  practice, 11-144
  production, 9-59
  proximity switch, 9-9
  pulp consistency, 8-70
  punched card, 6-64; 8-9
  railroad traffic, 6-9
  refinery, 7-109
  remote, 6-58
  rerolling mill, 6-64
  sequencing, 6-69
  servo, 8-71; 9-66
  solid state, 11-16
  static, 8-12; 11-144
  tape preparation for, 11-81
  temperature, 7-16; 9-66
  theory, 9-48; 11-144
  tracer, 11-37
  traffic light, 6-10
  transistors in, 6-10
  types, 9-48
  under voltage protection, 11-60
  valve, 9-66
  voltage stabilization, 11-60
Converter housing manufacture, 7-64
Conveyors,
  automobile assembly, 9-37
  bulk material, 8-54
  control, problem, 10-136
  drive system, 8-16
  paper rolls, 6-49
  radiation processing, 11-84
  spray painting, 11-10
  transfer devices, 7-61; 9-62
  x-ray inspection, 11-9
Cost estimating, 11-140
  weighing, 7-34
Counting, cartons, problem, 9-156
Culling mail, 11-53
Cutoff, slab, 7-72
Cutoff and chamfer, problem, 8-126; 10-136
Cutting,
  tube problem, 7-122; 9-156
  wire problem, 8-126

D

Damschroeder, E.
  Handling Devices Speed Washer Cabinet Production, 7-41
Data presentation, 11-42
Data processing, 6-10; 7-10; 8-14; 9-24; 10-16; 11-19, 65, 146
  components, 9-75
Data recording, 7-12; 9-9
Data reduction, 11-42
Data storage, 8-12
Depth control, on jig borer, 10-81
Deschenes, P. L.
  Assembly By Diecasting Improves Product Quality, 9-79
Design,
  for production, 7-118
  of packaging machine, 8-42
Detectors,
  dial rotation, 10-24
  flow, 8-14
  page alignment, 8-55
Developing manufacturing engineers, 10-50
Diecasting, 9-79
Digital display device, 7-10
Dispatching, sorted cartons, 10-66
Do-it-yourself automation, 10-43
Drilling, 8-64; 9-9
  numerical control, 8-45

E

Economics, 8-9; 11-10, 140
Education, 7-25
Ejecting work-in-process, 8-55
Elder, J. C.
  Basic Electrical Controls, 7-44
Electrical,
  baking, 8-48
  connections, 11-143
  controls, 7-44; 9-51; 10-67, 128
  feedback, 7-72
  heaters, 11-20
  keyboards, 8-18
  leveling device, 8-18
  machine control, 10-67
  network synthesis, 6-130
  voltage stabilization, 11-60
Electrohydraulic positioning device, 10-66
Electronics,
  assembly, 9-83
  building blocks, 6-34
  data processing, 6-10; 8-12; 9-75
  designers' handbook, 8-122
  future growth, 6-10; 9-149
  maintenance control, 7-14
  paging system, 8-18
  super-conducting elements, 9-75
  testing devices, 6-19
  thermoelectric materials, 10-14
  traffic control, 6-10
Enameling aluminum sheets, 10-39
Engineering,
  of manufacturing processes, 10-44
  postal operations, 11-52
  processing, 6-121
Estimating,
  machining costs, 8-122
  screw machine, 11-146
Everstine, E. L.
  Transferring Racks Automatically, 7-61
Extruding insulation, 10-55
Extrusion metal, 10-10

F

Facing letters, 11-55
Feasibility studies, 11-140
Feedback control, slab cutoff, 7-72
Feeders,
  for small parts, 7-53; 8-10
  packaging machine, 10-72
Feeding,
  discrete parts, 11-150
  granules to extruders, 10-55
  inked paper, 11-80
  pin-shaped bodies, 9-150
  sheet metal, 9-62
  small ball shapes, 11-72
  tablets, 8-42
  thin materials, problem, 6-135
Filmer, T.
  Feedback Controlled Steel Slab Cutoff, 7-72
Finishing, 8-66
  metal coating, 9-12, 19
  rubber parts, 10-19
Fixtures for milling machines, 7-53
Flow control, 9-14, 66
Flow meters, 11-146
Food processing, 8-12, 49
Force measuring, dynamic, 9-81
Forging press, 11-66
Forming,
  sheet materials, 11-47
  titanium hemisphere, 8-30
Foundry, automated, 8-38; 10-73
Frodge, R. E.
  System Sorts and Dispatches Cartons, 10-66
Fuel production, 8-16

G

Gaging,
  in control, 10-69
  in-process, 6-16; 11-139
  post-process, 11-139
  thickness, 8-65
Garrison, J. L.
  Applying Infrared Analyzers to Control Furnace Atmospheres, 6-46
Glass,
  manufacture, 8-25
  sealing, 11-12
Goldberg, R., 6-25
Grease, multipurpose, 7-16
Grinding,
  control, 10-67
  wheels, for paper feeding, 11-80
  wheel manufacture, 9-14

H

Hadekel, R.
  Hydraulic Control of Automatic Machinery, 6-69; 8-71
Handling,
  automobile assembly, 9-37
  bulk materials, 10-55
  by tractor, 8-20
  cans, 9-44
  cartons, 10-66
  coil splicer, 9-86
  for casting, 8-38
  for grinding, 9-78
  for painting, 11-19
  for plating, 7-61
  in multislide press, 7-60
  in warehouse, 11-37
  lumber, problem, 10-136
  magnetic control, 9-150
  magnetic fixture, 8-64
  molten metal, 9-14
  pallets, 6-14; 9-74
  paper bags, 11-37
  paper broke, 8-70
  paper rolls, 6-49
  pharmaceuticals, 8-42; 11-84
  plastic granules, 10-55
  pneumatic, 10-55
  refrigerator cabinets, 11-47
  sheet metal, 5-89; 7-41; 9-62
  shell molds, 10-73
  television tubes, 11-150
  tin plate, 8-54
  to machine tools, 7-53
  transferring, 11-66
  water tanks, 10-16
Hardness testing, 11-69
Harris, S. E.
  Plant Develops Own Pharmaceutical Packager, 8-42
Heat treating, 6-46; 8-64
Heumann, G. W.
  Counteracting Voltage Dips, 11-60
Hulley, O. S.
  Developing Manufacturing Engineers, 10-50
Hydraulics,
  actuators, 8-71
  automatic sequencing, 6-69
  components, 7-113; 9-26, 71
  control, 6-69; 7-113; 8-71; 9-71
  drive system, 7-52
  expander machine, 10-14
  feedback, 7-72
  for machine tools, 7-25; 9-71; 11-22
  press system, 9-29
  servo systems, 8-71; 9-14
  systems engineering, 8-71

I

Impulse counter, 9-16
Indexing, assembly machines, 7-55; 10-59; 11-82
Industrial engineering, 11-14
Information handling, 6-10
Infrared analyzers, 6-46
Infrared heating,
  applications for, 8-49
  oven design factors, 8-49
  source characteristics, 8-49
Inserting pins, 11-150
Inspection,
  closed circuit television, 6-58
  electronic, 6-16
  gaging, 10-69
  hardness testing, 11-69
  radioactivity, 7-12
  television x-ray, 11-9
  testing, 7-28
Instrumentation,
  in refineries, 7-109
Instruments, 11-31
Integrated standard machines, 6-57
Integrating automatic operations, 6-57
Intensifiers, air-hydraulic, 7-67
Inventions, 6-25
Inventory planning, 11-144

J

Janke, F. C.
  Electromechanical System Aids Centralized Production Control, 9-59

K

Krupp, P. H.
Infrared Radiant Heating Improves Manufacturing Processes, 5-49

L

Lathes, numerical control, 7-57
Layout and dimensioning, 6-130
Leasing, machine tools, 7-12
Leone, W. C.
Building-Block Controls, 11-75
Letter processing, 11-52
La Donnicci, K.
Special Evaporation Plater, 11-72
Load sensing devices, 7-37
Loading, 9-78
Logic devices, 7-44
Lubrication alarm device, 11-12
Ludwig, W. D.
Special Pneumatic Circuit Provides Control of Machine Masses, 10-82
Lysaght, V. E.
Add Speed to Precision by Testing Hardness Automatically, 11-60

M

Machine tools,
air line protection, 10-125
boring, 8-18
card controlled, 10-79
control, 9-48, 66; 10-128
fixture for, 7-53
forging press, 11-66
grinding, 9-78; 10-67
hydraulically operated, 7-25
indexing, 9-86
jig borers, 10-75
lathes, numerically controlled, 7-57
leasing, 7-12
presses, 9-29
tape controlled, 6-34; 10-78
tracer controlled, 7-28
transfer, 7-64; 10-31
Machines,
anodizing, 9-88
assembly, 10-59; 11-82
billet mill, 10-12
boring, 7-18
carton stacking, 6-60
cigar manufacturing, 9-16
circuit board, problem, 6-135
control of masses, 10-82
corner bead, 11-12
design trend, 6-121
diecasting, 9-79
drilling, 9-9, 16
evaporation plater, 11-72
extrusion press, 6-12; 10-10
flash removal, 10-19
gaging, 10-69
gear shaver, 11-20
glass tube annealing, 9-86
hydraulic expander, 10-14
jet blade milling, 8-76
lithograph press, 9-62
marking, 9-86
molding rubber, 7-9
packaging, 8-42; 10-72; 11-136
painting, 11-10, 14
palletizing, 11-37
paper laminating, 7-52
planning, 9-19
powder rolling, 10-9
press extractor, 10-82
riveting, 9-12; 11-14
slitting, 9-62
spotwelding, 9-43; 10-31
static balancing, 9-144
steel strapping, 7-16
strip splicer, 9-86
tape-card conversion, 9-86
testing, 6-19; 11-69
textile, 7-111
welding, 11-16, 47
Madison, J. E.
Pneumatic Valve Positioners Provide Servo Action, 9-66
Magnetic,
recording techniques, 8-122
tape preparation, 11-81
tape recorders, 6-50
Magnetostrictive motor, 9-150
Magnets, permanent, 11-144
Mail processing, 11-52
Maintenance,
control system, 7-14
planning, 11-144
Management for Engineers, 6-130
Manufacture of,
blower fans, 9-43
cans, 8-54
carbon bricks, 8-48
circuit breakers, 10-59
control components, 6-34; 10-59
converter housings, 7-64
crankshaft castings, 10-73
drums & pails, 9-62
electric motors, 11-82
electronic equipment, 9-83
engine block castings, 8-38
forgings, 11-66
gasket retainers, 6-57
glass, 8-25
jet engine blades, 8-76
magazines, 8-55
metal parts, 6-130; 9-74
meter components, 9-79
missiles, 8-62
paper, 8-70; 11-42
pharmaceuticals, 8-42
plastic items, 8-49
plastic pellets, 8-65
pulp insulation, 6-58
quartz crystals, 11-72
refrigerator cabinets, 11-47
shoes, 8-49
speedometers, 9-144
textiles, 7-111
textile belting, 8-49
tin plate, 11-42
transistors, 11-135
truck trailers, 11-14
washer baskets, 6-68
washer cabinets, 7-41; 8-49
Manufacturing engineering, 10-44
training, 10-50
Manufacturing team, 8-34; 10-50
Marking hot metal, 9-86
Materials handling, 10-10
Measurement, thickness, ultrasonic, 9-159
Measuring,
flow, 11-146
force, 9-81
wire length, 11-22
Mechanical controls, 9-50
Memory,
components, 9-75
devices, 8-12
Meter-relays, 10-67
Milling machine control, 9-54
Modular concepts, 9-83
Mohr, P. A.
Instrumentation Applications of Magnetic Tape Recording, 6-50
Mold production,
foundry, 8-38; 10-73
Molding,
plastics, 6-59
rubber, 7-9
wax discs, problem, 10-136
wax tires, problem, 6-135
Moritz, J. M.
Basic Pneumatics for Automation, 7-67
Motion indicator, 7-16
Motors,
starting, 7-44
stopping, 7-44
undervoltage protection, 11-60

N

Numerical control, 7-25, 57; 10-75; 11-81
in positioning, 8-45
machine tool system, 6-34
of rolling mill, 6-64
riveting machines, 9-12
systems, 7-118; 10-9

O

On-off control, 9-51
Opel, E. E.
Applying Pressure Switches for Position Control, 9-71
Open loop control, 9-48
Operations research, 11-144, 146
Organization of manufacturing engineering, 10-44
Orienting, C-shaped articles, 11-150

P

Packaging, machines, 8-14, 42; 10-72; 11-136
plastic blister, 8-14
Paging system, 8-16
Painting, 8-66; 9-12; 10-10, 39; 11-10, 14, 19
Painting fixture, magnetic, 8-64
Pallet unloading, 6-14
Palletizing machine, 11-37
Parts production, control, 9-59
Patents, 8-122
Pilot devices, 7-44
Pipeline protection, 7-14
Plating,
machine system, 7-61
vacuum, 11-72
Pneumatic,
card positioning, 9-86
combination circuits, 7-67
feedback, 7-72
line protection, 10-125
motion control, 10-82
valve positioners, 9-66
Positioning,
automatic control, 9-48
card sensing, 9-86
electrohydraulic, 10-66
electromechanical, 10-75
hydraulic, 6-69; 9-71
numerical control, 8-45; 10-9
pneumatic, 9-66
servo, 8-71
tool, 11-150
Powder metallurgy, 10-9
Power devices, 7-44
Presses,
extrusion, 6-12
feeding, 9-74
feeding, problem, 7-122; 8-126; 9-157
multislide, 7-60
multistage die set, 8-30
transfer devices, 7-60
unloading, 9-74; 10-82
Pressure,
magnetic tape recording, 6-50
switches, 9-71
Pressworking of sheet metal, 9-152
Printing device, 7-20; 9-16
Process,
enameling aluminum, 10-39
extrusion, 6-12
glass sealing, 11-12
metal fabricating, 6-130
refinery, 7-109
rubber molding, 7-9
weighing, 7-34
Processing,
mail, 11-52
radiation, 11-84
Product design, 8-34
Production,
control system, 9-59
engineering, 8-34
Programming, 5-24
electric switch, 8-9
numerically-controlled line, 6-34
rolling mill, 6-64
tape preparation, 11-81
Proportional control, 9-53
Punched cards, 6-64
in data processing, 6-10
in inspection, 8-9
in tape preparation, 11-81
Punched tapes, 8-9; 11-87
machine control, 7-57; 8-45
Pushbutton stations, time-delay, 11-60

R

Radiation gages, 6-10; 7-12, 16; 8-65
Radiation processing, 11-84
Radio tone system control, 6-10
Radioisotopes in industry, 6-10
Railroad traffic control, 6-9
Reading addresses, 11-58
Recording,
physical functions, 6-50
production statistics, 9-59
Relays,
control, 11-67
latching, 11-60
Reliability, of electrical connections, 11-143
Rice, V. C.
Making Refrigerator Cabinets on an Automated Welding Line, 11-47
Riveting, automatic machine, 11-14
Roberts, C. C.
Feedback Controlled Steel Slab Cutoff, 7-72

S

Sammons, C. J.
Typewriter Subassembly, 7-55
Sanding, 11-22
Scales, weighing, types of, 7-39
Sensing, 9-14
heads, problem, 8-126
linear speed, problem, 7-123
proximity switches, 9-9
Sequencing, anodizing operations, 9-88
Servo,
actuators, 7-57
controlled machine tools, 7-25
systems for velocity and position control, 8-71
valves, 8-71
Sisson, R. L.
Obsolescence and EDP, 9-75
Small cars, 10-31
Soldering, 10-59; 11-25
Sorting,
cartons, 10-66
gaged parts, 10-69
letters, 11-55
parcels, 11-58
Speed,
changing, 7-44
magnetic tape recording, 6-50
Spinning, 8-30; 10-59
Spotwelding machines, 10-31
Spray painting, 8-66; 11-10, 14
Staking, 10-59
Staley, J. A.
Intergrating Standard Machines to perform Special Jobs, 6-57
Standards,
pneumatic control systems, 7-118
tubing color code, 6-4
Starters, motor, 7-44
Statistics, engineering use, 9-152
Stewart, H. L.
Basic pneumatics for Automation, 7-67
Stiles, J. W.
Package Conveying System, 6-60
Storage systems, 6-14; 9-44
Subassembly, automation of, 7-55
Survey, automation, 11-10
Symbols, geographical fluid, 11-146
Systems,
hydraulic, 6-69
maintenance control, 7-14

T

Tape,
control, of transfer line, 11-76
eraser, 6-16
magnetic recording, 6-50
preparation, 11-81
punched, 7-57
Tape controlled,
jig borer, 10-75
machine tool system, 6-34
Tape programmed milling machines, 7-25
Teletypewriter system, 11-65
Temperature control, 6-16
magnetic tape recording, 6-50
Template controlled,
milling machine, 8-76
Tension control, 11-150
Terminology, control, 9-52
Testing, 11-31
brazed conductors, problem, 8-127
electrical, 7-28
hardness automatically, 11-69
inspection, 8-16
oil well, 8-57
springs, 9-81
vacuum tubes, 6-19
Training manufacturing engineers, 10-50
Transfer devices, 7-41, 60, 61; 9-16
Transfer machines, 7-64; 10-31
air line protection, 10-125
numerically controlled, 6-34
tape controlled, 11-76
Transferring, 11-66
Transformers, voltage stabilizing, 11-60
Transistors, 9-149
manufacture of, 11-135
TV,
closed circuit, problem, 7-122; 9-156
closed system planning, 7-118
x-ray inspection, 11-9

U

Under voltage protection, 11-60

V

Vacuum lifting, 10-16
Valves,
control, 7-113; 10-82
electrohydraulic, 8-71; 10-66
servo, 7-113; 8-71; 9-14
Vibration, magnetic tape recording, 6-50
Voltage stabilization, 11-60

W

Walker, J. R.
Elements of Automatic Control, 9-48
Weigher-feeder scales, 7-40
Weighing,
bulk materials, 7-34
crane problem, 7-123
missiles, 8-62
paper rolls, 6-49
Welding, 8-14
production line, 6-68; 7-41; 11-47
ultrasonic, 11-16
Williams, J. C., Jr.
Automatic Weighing Techniques for Processing Bulk Materials, 7-34
Wiring, conveyor system problem, 9-156

X

X-ray inspection, 6-10; 11-9, 84

Y

Yomine, D. J.
Manufacturing Team for Automation, 8-34

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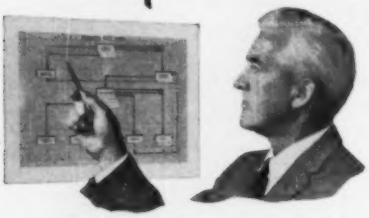

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Circle 740 on Page 155

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Circle 741 on Page 155

AUTOMATION patents

Copies of patents are available at 25 cents each from the Commissioner of Patents, Washington 25, D. C.

MACHINE FOR APPLYING STOPPERS TO BOTTLES

Stem and flange type resilient stoppers are conveyed to a station and are loosely held with the stopper axis substantially horizontal. Bottle conveyed past the station contacts the flange of a stopper and swings the stopper onto the bottle. Patent 2,821,823 by Eugene A. Wahl, assigned to Olin Mathieson Chemical Corp.

FEEDING MACHINE

Workpieces are delivered in bulk to the interior of a lift ring revolving about a horizontal axis. Lifting compartments pick up workpieces and deposit them in discharge means for feeding in a continuous stream. Patent 2,825,489 by James W. Batchelder, assigned to Batchelder Engineering Co. Inc.

CONVEYING SEMI-LIQUID, PLASTIC, LOOSE OR PASTE-LIKE MATERIALS

Flexible tube is surrounded by a rigid jacket having spaced sections which alternately narrow and increase in diameter around the tube. Pressure medium is intermittently fed in the space between the jacket and tube to create pressure waves which cause material to move through tube. Patent 2,829,600 by Vladimir Sveda, Prague, Czechoslovakia.

TOOL-FEEDING MEANS

In a machine tool, a work probe continuously tracks the cut of tool on a workpiece. Probe position is electrically compared to a reference setting, and resulting error signal continuously controls tool feed. Patent 2,831,387 by Stanford R. Ovshinsky, assigned to New Britain Machine Co.

ORIENTATOR FOR C-SHAPED ARTICLES

C-shaped parts randomly drop between two spaced apart, oppositely rotating rolls. Raised helical threads on surface of rolls cause parts to tumble and move back toward feed point. As parts become oriented, they fall onto a carrier between the rolls which moves them away from feed point and out of the device. Patent 2,832,457 by Joseph L. Randles, assigned to Clevite Corp.

AUTOMATIC INSERTION OF PINS, ETC., IN HOLES

Horizontal perforated plate oscillates up and down causing pins and other headed objects to be agitated and to fall into holes in the plate. Intermittent means urges the pins downward into the holes. Patent 2,833,091 by William E. Whitney, assigned to Comstock & Wescott Inc.

MACHINE FOR COATING SPHERICAL OBJECTS

Spherical object, such as a golf ball, is guided into a high velocity air stream which lifts, supports, and confines the object while it is being spray coated. Patent 2,833,241 by George C. Crowley and Robert J. Sertl.

ARTICLE HANDLING MECHANISMS

Television tube blank, filled with screen settling fluid, is conveyed face down and stem up to a transfer station. Transfer head grips face of tube, lifts and rotates tube 180 degrees to empty fluid while moving in a horizontal arc toward a second conveyor. Tube is released on second conveyor with the stem down and face up. Patent 2,833,434 by Gerald A. Stover and Earl F. Walts, assigned to Sylvania Electric Products Inc.

ROLL UNWINDING CONTROL SYSTEM

Tension in sheet material unwinding from a roll is controlled by sensing the number of revolutions of the roll and periodically changing the energization of an electrically controlled roll brake after a selected number of revolutions of the roll. Patent 2,838,253 by Paul W. Jacobsen, assigned to H. G. Weber & Co.

Advertising Index

A'G'A Division Elastic Stop Nut Corporation of America 128
Allen-Bradley Co. 121
Alvey Conveyor Manufacturing Co. 36
Alvey-Ferguson Co., The 92
American Blower Division, American-Standard 115
American Can Co. 117
American Chain & Cable, Automotive & Aircraft Division 146
American-Standard, American Blower Division 115
Ampex Corporation, Ampex Instrumentation Division 93
Appco Corporation 141
Aurora Equipment Co., Equipto Division 144
Automation Devices, Inc. 147
Automation Machines & Equipment Co., Inc. 130
Automotive & Aircraft Division American Chain & Cable 146

Baker Brothers, Inc. 95
Beckett-Harcum Co., The 140
Bellows Co., The, Division of International Basic Economy Corporation 32, 33
Bell Telephone Laboratories 86
Benerson Corporation 25
Brush Instruments Division of Clevite Corporation 35
Buckeye Tool Corporation 28
Buschman, E. W., Co., The 131

Campbell Machines Co. 144
Cincinnati Milling Machine Co., The 6, 7
Cleveland Electric Motor Co., The 141
Cleveland Worm & Gear Co., The, Speed Variator Division 11
Clevite Corporation, Brush Instruments Division 35
Clippard Instrument Laboratory, Inc. 147
Crescent Tool & Machine Co., Inc. 118
Crown Zellerbach Corporation, Gaylord Container Corporation Division 23

Denison, R. B., Mfg. Co. 116
DeVilbiss Co., The 104
Duff-Norton Co., Coffing Hoist Division 125

Edison, Thomas A., Industries, Instrument Division ..... Back Cover
Elastic Stop Nut Corporation of America, A'G'A Division 128
Electro Products Laboratories 96
Enterprise Machine Parts Corporation, The .. 138
Equipto Division of Aurora Equipment Co... 144
Eriez Manufacturing Co. 8
Exact Weight Scale Co., The 22

Falk Corporation, The 85
Ferguson, J. L., Co. 119
Ferguson Machine Corporation 123
Fosdick Machine Tool Co., The 26, 27
Foxboro Co., The 134
Fuller Co. 137

GPE Controls, Inc. 90, 91
Gaylord Container Corporation, Division of Crown Zellerbach Corporation 23
General Controls Co. 113
General Controls Co., Production Instruments Division 126
General Electric Co. 38, 39, 40
General Precision Equipment Corporation ..90, 91
Gray Equipment Co. 105
Greenlee Brothers & Co. 152

Hannifin Co., A Division of Parker-Hannifin Corporation 17
Hansen Manufacturing Co., The 94
Hi-Lo Manufacturing Co. 133
Hinde & Dauch Division of West Virginia Pulp & Paper Co. 19
Howe Scale Co., The 114
Hunt Valve Co. 2

International Basic Economy Corporation, The Bellows Co. Division 32, 33

Labelon Tape Co., Inc. 150
Lansing Stamping Co. 142
Lindly & Co. 147
Lipe-Rollway Corporation 129
Logan Co. 132
Logansport Machine Co., Inc. 5
Lynch Corporation 30

McGill Manufacturing Co., Inc. 15

M-B Products 142
Magnetics, Inc., Controls Division 24
Mathews Conveyor Co. 127
Matthews, James H., & Co. 124
Mayes Tool Co. 142
May-Fran Engineering, Inc. 143
Metzgar Conveyor Co. 145
Modernair Corporation 103

Ortman-Miller Machine Co. 112

Parker-Hannifin Corporation, Hannifin Co. Division 17
Production Instruments Division of General Controls Co. 126

Reliance Electric & Engineering Co. ....Inside Back Cover
Richardson Scale Co. 139
Ross Operating Valve Co. 1

Sandvik Steel, Inc. 98, 99
Schrader's, A., Son, Division of Scovill Manufacturing Co., Inc. 21
Scovill Manufacturing Co., Inc., A. Schrader's Son Division 21
Sheffield Corporation, The 106
Skinner Electric Valve Division 13
Southwest Products Co. 145
Standard Conveyor Co. 97
Standard Instrument Corporation 145
Standard Tool & Manufacturing Co. 102
Swanson-Erie Corporation 141

Thayer Scale Corporation, The 120
Tubular Rivet & Stud Co. 110, 111

Universal Relay Corporation 150

Warrick, Charles F., Co. 145
Wean Equipment Corporation ....Inside Front Cover
Weighing & Control Components, Inc. 29
Westinghouse Electric Corporation 100, 101
West Instrument Corporation 122
West Virginia Pulp & Paper Co., Hinde & Dauch Division 19

Yoder Co., The 20

Zenith Electric Co. 142

Consulting Engineer's Service 151

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Circle 742 on Page 155

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Air Line Equipment

Wilkerson Corp., 1552 *W. Girard Ave., Englewood, Colo.*—20 *page booklet*—Data are contained in Bulletin 157 on line of automatic moisture separators, lubricators, regulators, filters, and filtrators for compressed air systems. Operation of each unit is covered and the automatic draining of receiver tanks explained. Also described are the products for automatic filtration of oil, oil fumes, and solid contaminants.

Circle 476 on Page 155

Coal Handling

Link-Belt Co., Prudential Plaza, Chicago 1, Ill.—16 *page booklet*—"Methods of Handling Coal at Today's Power Plants" is title of Bulletin A-2029. Typical problems, such as unloading coal from trucks, feeding coal to the system uniformly, and conveying and elevating, are discussed and suggested solutions given. Other points reported on are distribution, storage, dust control, and drying.

Circle 477 on Page 155

Dust Collector

Joy Mfg. Co., Henry W. Oliver Bldg., Pittsburgh 22, Pa.—12 *page booklet*—Cylindrically-shaped, horizontally mounted, dust collector is the subject of Bulletin J-616. Cutaway photos show inner construction of the collector; sketches show the air flow operation. Also mentioned is a filter which can be added to the collector to remove the collected slurry.

Circle 478 on Page 155

Power Transmission

Clearing Machine Corp., Div., U. S. Industries Inc., 6499 *W. 65th St., Chicago 38, Ill.*—8 *page bulletin*—Model 20, a transmission mechanism which consists of a clutch, brake, and speed reducer is described. Construction of the components is explained and its application on conveyors, transfer cars, rapid traverse drives, feeds, adjustment drives, shears and paper cutters, and machine tools is discussed. Installation drawings are given showing different mounting positions and motor drive arrangements.

Circle 479 on Page 155

Electronic Gage

Computer Measurements Corp., 5528 *Vineland Ave., North Hollywood, Calif.*—4 *page pamphlet*—Data are given on Model 620A, an electronic gage designed for frequency stability and comparison checks, motor speed control, pressure and flow control, material flow control, and other limiting situations occurring between 1 and 40,000 times per second. A description of the basic design is given and functions of the instrument in the different applications are explained.

Circle 480 on Page 155

Integral HP Motors

Leland Electric Co., Div., American Machine & Foundry Co., P. O. Box 1060, Dayton 1, Ohio—8 *page bulletin*—Data are given in Bulletin 104 on single and polyphase integral horsepower induction motors up to 20 hp. Construction features of the components (end frames, bearings, rotor assembly, and stator assembly) are explained. Charts list motor frame sizes and dimensions.

Circle 481 on Page 155

Relay Data

Magnecraft Electric Co., 3554D *W. Grand Ave., Chicago 51, Ill.*—20 *page booklet*—Microminiature rotary relays, telephone type relays, snap action relays, and time delay relays are among units described in Catalog 159. Specifications and available mountings are listed. Data are also given on hermetically sealed and dust tight enclosures, removable dust covers, and observation window enclosures.

Circle 482 on Page 155

Temperature Control

Illinois Testing Laboratories Inc., 420 *N. LaSalle St., Chicago 10, Ill.*—8 *page bulletin*—Instrument, described in Bulletin 2002, is a temperature protective device that sounds an alarm, lights a signal light, and shuts off heater circuits or fuel supply. Principle of operation is explained, aided by schematic wiring diagrams. Sketches show different arrangements for various applications.

Circle 483 on Page 155

Thermocouple Assemblies

Thermo Electric Co. Inc., Saddle Brook, N. J.—22 *page booklet*—Bulletin EDS-47 contains data on multithermocouple assemblies which are used to obtain temperature readings at various levels in deep vessels, reactors, catalyst beds, and furnaces. Specifications are given for the components in a thermocouple assembly (thermocouples, extension wire, thermowells, mounting attachments, connection heads, and fittings). Details are given on the different types of construction.

Circle 484 on Page 155

Air Cylinders

Lynair Inc., 3100 *E. Michigan, Jackson, Mich.*—24 *page catalog*—Data are contained in Catalog SA7 on line of square type, double acting air or oil cylinders rated for 200 psi. The different square types of cylinders include: Air, airdraulic, air booster, and low pressure. Schematic drawings show the construction and design features of the different styles.

Circle 485 on Page 155

Conversion Coating Machine

Hanson-Van Winkle-Munning Co., Church St., Matawan, N. J.—4 *page pamphlet*—Automatic straight line conversion coating machine is the subject of Bulletin FAC-200. Blackening, phosphating, bright-dipping, precleaning, and pickling operations are described, as are the use of selective timers for in-process flexibility. Also mentioned is the machine's ability to adapt itself for conveying trays and baskets; a new style automatically operated horizontal barrel is described in detail.

Circle 486 on Page 155

Visual Weight Indicators

Streeter-Amet Co., Grayslake, Ill.—4 *page pamphlet*—Two instruments are described which are suitable for applications where printed weights are not required. The instruments are a visual numerical indicator and a visual dial. Specifications and accessories are listed. Also mentioned are desk and cabinet models of printing weight recorders.

Circle 487 on Page 155

Motorized Devices

Globe Industries Inc., 1784 *Stanley Ave., Dayton 4, Ohio*—9 *page bulletin*—Data are given on instrument panel vibrators, dc generators, planetary gear reductions, clutches, differentials, actuators, timers, and power positioners. Charts show performance characteristics and sketches show the dimensions of the different components.

Circle 488 on Page 155

Automatic Data Systems

Kybernetes, Div., Hagan Chemicals & Controls Inc., 323 *Fourth Ave., Pittsburgh, Pa.*—4 *page pamphlet*—Electronic, automatic data systems for collecting and subsequent logging, monitoring, and computing of process information are described in Bulletin MSP-154. Different functions of the system, such as programming, switching, analog to digital conversion,

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and linearization are explained. Also included are an accuracy chart and block diagram of the basic functional operations.

Circle 489 on Page 155

Pressure Switches

Century Electronics & Instruments Inc., 1333 N. Utica, Tulsa 10, Okla.—28 page catalog—Data on line of miniature, precision pressure switches are contained in Catalog CEI-602. Features and test standards of the basic switch are noted, and a reference chart is given which lists the different models and their characteristics. Other charts list mountings and standard brackets, contact arrangements, pressure fittings, and mounting diagrams. Also included are definitions of special terms used.

Circle 490 on Page 155

Weight Controls

Richardson Scale Co., Van Houten Ave., Clifton, N. J.—6 page pamphlet—Automatic weighing system is described in Bulletin 0557. System consists of electrical controls which operate the gates, feeders, scales, mixer, conveyors, and other equipment used in blending materials. The different weight selectors and remote control panels are explained, as is the punched card reader control—a system for automatic proportioning and mixing.

Circle 491 on Page 155

Indexed Welders

Taylor-Winfield Corp., Warren, Ohio—10 page bulletin—Line of geneva indexed welders for spot, projection, or seam welding is outlined in Bulletin 8-213. Equipment is also suitable for resistance brazing or riveting operations. A five station geneva index mechanism is explained, aided by sketches and illustrations.

Circle 492 on Page 155

Continuous Flow Systems

Industrial Nucleonics Corp., 1205 Chesapeake Ave., Columbus 12, Ohio—12 page booklet—Bulletin NI-158 contains data on AccuRay density measurement system. This system is capable of measuring density, specific gravity, per cent solids, or concentration in liquids, slurries, or divided solids. Principles of operation are explained, aided by schematic diagrams. Construction and design features are covered and wiring instructions given. Also included are illustrative examples of various applications.

Circle 493 on Page 155

Barrel Finishing

Electro Minerals Div., Carborundum Co., Niagara Falls, N. Y.—20 page booklet—Function of tumbling barrels and the different methods of barrel finishing are described. Kinds of applications include deburring, blending, descaling, polishing, and burnishing. The types of abrasive tumbling media most suitable for the various applications are discussed, and appropriate compounds, cleaners, and barrel speeds are given. Suggestions are included for getting the best finishing results.

Circle 494 on Page 155

Synchronous Induction Motor

Louis Allis Co., 427 E. Stewart St., Milwaukee 1, Wis.—8 page bulletin—Unit, designated Syncro-Spede is the subject of Bulletin 1900. It is applicable for frequency drives, precise timing, metering and recording devices, and constant speed conveyor drives. Principle of operation is explained and sketches show the design features. Performance charts are also included.

Circle 495 on Page 155

Hydraulic Feed Machines

Baker Brothers Inc., 1000 Post St., Toledo 10, Ohio—16 page booklet—Horizontal units which are designed for single or multiple spindle drilling, boring, tapping, or milling, are described in Bulletin 619. The basic unit and its design features are illustrated. Notes on both the fixed center drill head and the adjustable spindle head are given. Charts list specifications, spindle speeds, and dimensions.

Circle 496 on Page 155

Balanced Vane Pumps

Vickers Inc., 1400 Oakman Blvd., Detroit 32, Mich.—4 page pamphlet—Line of balanced vane pumps, which operate at speeds up to 2000 rpm and pressures up to 2000 psi, is outlined in Bulletin M5108. Characteristics and capacities of the pumps are noted, and performance charts given.

Circle 497 on Page 155

Industrial Batteries

C & D Batteries Inc., Washington & Cherry Sts., Conshohocken, Pa.—16 page booklet—Storage batteries for industrial applications are described. The PlastiCell construction is explained and photos show the different components which make up the batteries. Performance charts display discharge characteristics for the various models. The battery's use in the paper, steel, and rubber industries is also mentioned.

Circle 498 on Page 155

Automatic Conveyor Control

A. J. Bayer Co. Inc., Slauson & Santa Fe Aves., Los Angeles 58, Calif.—4 page pamphlet—An automatic, selected station electronic timer for conveyor systems is the subject of Form A-958. The control panel which can be operated by magnetic tape is explained and sketches show typical layouts.

Circle 499 on Page 155

Indexing Machine Chassis

Swanson-Erie Corp., 814 E. Eighth St., Erie, Pa.—10 page bulletin—Data are given on turret type bases which are designed for automatic equipment for sequential machining, processing, and assembly operations. Indexing mechanism is explained and notes on construction, operation, and maintenance are given. Also covered are accessories such as the overhead tool mounting plate, reciprocating and rotating center shafts, stationary center plates, and mounting brackets.

Circle 500 on Page 155

Centralized Lubrication Systems

Lincoln Engineering Co., 5794 Natural Bridge Ave., St. Louis 20, Mo.—4 page pamphlet—Pumping units for both low pressure and high pressure applications are discussed in Bulletin 812. These units are designed to provide automatic or semiautomatic lubrication of bearings, simultaneously on single machine units. Also included are data on lubrication injectors which are used with the pumps.

Circle 501 on Page 155

Recording Volt-Ammeter

General Electric Co., Schenectady 5, N. Y.—16 page booklet—Portable and switchboard models of recording volt-ammeters and inking recorders are described in Bulletin GEA-6821. Features, applications, ratings, and prices are given. Sketches show step-by-step procedure for installation.

Circle 502 on Page 155

Totalizing Flow Meter

Builders-Providence Inc., Div., B-I-F Industries Inc., 345 Harris Ave., Providence 1, R. I.—6 page pamphlet—Velocity type totalizing flow meter is the subject of Bulletin 380-K4B. Operation and function of the unit are explained, and charts show pressure and accuracy curves. Flow ranges and dimensions are noted, and photos display installation procedure.

Circle 503 on Page 155

Master Switches

Furnas Electric Co., 1128 McKee St., Batavia, Ill.—8 page bulletin—Data are contained in Bulletin 5701A on master switches which can be used to provide single handle pilot control of hoists, cranes, oven pushers, car movers, and other equipment that have wound rotor or dc motors. Switches are available in circuit combinations from 1 through 5

speeds in either or both *Forward* or *Reverse* direction. Schematic drawings show outline dimensions and charts list voltage ratings, contact arrangements, and prices.

Circle 504 on Page 155

Programming System

Remington Rand Univac, Div., Sperry Rand Corp., 315 Fourth Ave., New York 10, N. Y.—6 page pamphlet—Univac Math-Matic Programming, a coding shorthand system, is the subject of Folder U 1504. The programming technique makes it feasible to use Univac computers for one-shot jobs which normally are impractical to program. A sample problem is given in the folder and the procedures for solving it are explained.

Circle 505 on Page 155

Spiral Point Drilling

Cincinnati Lathe & Tool Co., 3207 Disney St., Cincinnati 9, Ohio—28 page handbook—Booklet SP-160 explains spiral point drills and reviews basic drilling practices. Some of the points covered are: Selecting the proper drill for the operation, the correct way to insert the drill into the spindle, and maintaining the proper condition of the drilling machine.

Circle 506 on Page 155

Transistor Digital Circuits

Epsco Inc., 588 Commonwealth Ave., Boston, Mass.—8 page bulletin—Line of encapsulated transistor digital circuits, available in two package styles and three temperature ranges, is outlined. They are suitable for use in data processing, computation, and timing operations. Schematic drawings show different types of circuit packaging and wiring arrangements. Tables list general circuits, diode logic circuits, and circuit symbols.

Circle 507 on Page 155

Metalworking Presses

Federal Machine & Welder Co., Warren, Ohio—20 page booklet—Power presses and their use in the metalworking industry is the subject of Bulletin 52151. The types of presses are described and suggestions for selecting the proper one are given. Fundamentals of press working of metals are discussed for the broad classifications of cutting, bending, pulling, and pushing.

Circle 508 on Page 155

Plastic Bearings

Thomson Industries Inc., Manhasset, N. Y.—8 page bulletin—Nylon bearings, which do not require lubrication, are described in Bulletin 209. Construction advantages are mentioned and operating principle explained. Charts list load ratings, prices, and dimensions. Also included are instructions for installation.

Circle 509 on Page 155

INDEX OF EQUIPMENT BY ITEM NUMBERS

(New Equipment, New Components, and New Literature covered in this issue)

Actuator, linear, 526
Air line equipment, 476
Amplifier, dc, 437
Annunciators, 515
  recording, 409
Applicator, adhesive, 413
Assemblies, thermocouple, 484
Assembly machine, 418

Barrel finishing, 494
Batteries, industrial, 498
Bearings, plastic, 509
Blower, rotary, 438
Bolster, moving, 403
Boring machine, 417
Brakes, post type, 447

Carton selector, 455
Circuit boards, 516
Circuits, digital transistor, 507
Clamping device, die, 403
Cleaning
  dust collector, 478
  washer, 407
Clock, air powered, 429
Coal handling, 477
Coating machines, 422, 486
Collector, dust, 478
Controllers, 459
  drum-type, 518
  indicating, 428
Controls, 518
  air line, 476
  carton selector, 455
  computer, 446
  conveyor, 499
  liquid level, 439
  press, 454
  system, 520
  temperature, 483
  voltage, 442
  weight, 491
Conveyors
  control, 499
  kit, 405
  packaged, 510
  swivel, 410
Cylinders, 471
  air, 485

Data processing, 439, 505
  control station, 446
  decimal keyboard, 473
  send-receive set, 423
Decimal keyboard, 473
Die clamping device, 403
Digital circuits, transistor, 507
Drilling
  machines, 417, 424, 496
  positioning system, 462
  press, air feed for, 431
  spiral point, 506
Drives, 427
  variable speed, 463
  worm gear, 475
Drying, chlorine, 511
Dust collector, 478

Electrical components, 429, 433, 437, 448, 449, 451, 466, 468, 481, 482, 488, 490, 495, 498, 504, 514, 515
Electronic gage, 480
Electronic recorder, 469
Equipment, plant, 521

Feed, for drill press, 431
Feeder, vibrating, 412
Filter, hydraulic, 440
Finishing
  barrel, 494
  coating machine, 422
Flowmeters, 503
  turbine, 524
Flow systems, 493
Flow transducer, 465

Gages
  electronic, 480
  pressure, 470
Gas proportioner, 458
Gear loading attachment, 420
Grinding
  mill, 517
  profile, 401

Handling
  carton selector, 455
  coal, 477
  conveyors, 405, 410, 510
  conveyor control, 499
  feeder, 412
  gear loader, 420
  pallet loading, 421
  storage units, 519
  weighing machine, 419
Heat processing, 425
Hose, industrial, 513
Hydraulic components, 426, 440, 441, 444, 453, 471, 497, 525
Hydraulic feed machines, 496

Indexing
  machine chassis, 500
  welders, 492
Indicators, weight, 487
Induction motor, synchronous, 495
Industrial
  batteries, 498
  hose, 513
Inserting, positioning system, 462
Instrument controls, 428, 435, 446, 459, 469, 518
Instrument indicators, 470, 502
Integral motors, 481

Keyboard, decimal, 473

Lathe, vertical, 414
Linear actuating equipment, 526
Loader, gear, 420
Loading machine pallet, 421
Lubrication
  oiler, 436
  pump, 434
  systems, 456, 501

Machine tool attachments
  die clamp, 403
  moving bolster, 403
Machine tools
  boring, 417
  drilling, 417, 424, 496, 506
  lathe, 414
  presses, 508
  profiling, 401
  transfer machine, 402
Machines
  assembly, 418
  coating, 422, 486
  package former, 404
  plastic molding press, 406
  processing, 425
  screwdriver, 523
  washer, 407
  welding, 408, 492
  wire cutter & stripper, 411, 522
Marking, bag printer, 415
Measuring, 458
  flowmeters, 503, 524
  flow systems, 493
  flow transducer, 465
  gage, 480
  liquid level controls, 439
  pressure gage, 470
  pressure transducer, 474
  pressure transmitter, 460
  temperature control, 483
  temperature recorder, 435
Metalworking presses, 508
Meter, flow, 503
Metering system, 520
Mill, grinding, 517
Milling, profile, 401
Molding press, plastic, 406
Monitor, power supply, 448
Motorized devices, 488
Motors
  hydraulic, 441
  induction, 495
  integral, 481

Nozzle, atomizing, 443

Oil well, panel, 464
Oiler, electric, 436

Packaging
  adhesive applicator, 413
  bag printer, 415
  carton former, 404
  pallet loading, 421
  tape dispenser, 416
Photoelectric relay, 452
Plant equipment, 521
Plastic molding press, 406
Plungers, spring, 432
Pneumatic components, 426, 428, 430, 431, 444, 450, 456, 457, 471, 472, 476, 485, 525
Pneumatic vibrator, 461
Positioning system, 462
Power supply monitor, 448
Power transmission, 479
Power transmitter, 475
Presses
  metalworking, 508
  plastic molding, 406
  safety control, 454
Pressure
  gage, 470
  switches, 466, 496
  transducer, 474
  transmitter, 460
Printer, bag, 415
Processing machine, 425
Profiling machine, 401
Programming system, 505
Proportioner, gas, 458
Pumps
  diaphragm, 467
  lubricating, 434, 501
  oil well panel for, 464
  piston, 441
  vane, 497
Punching, position system, 462

Recorder
  clock for, 429
  electronic, 469
  temperature, 435
Recording volt-ammeter, 502
Relays, 452
  electronic, 433
  photoelectric, 452
Rotary switch, 449

Screw machine tools, 512
Screwdriver, power, 523
Servomotor, 468
Servo valve, 453
Speed reducer, 475
Solenoid valves, 457, 472, 525
Spindles, motorized, 514
Spray nozzle, 443
Spring plungers, 432
Storage units, mechanized, 519
Stripper, wire, 522
Switches, 504
  key operated, 449
  pressure, 466, 496
Synchronous induction motor, 495

Tape controlled profiler, 401
Tape dispenser, 416
Temperature control, 483
Temperature recorder, 435
Testing
  annunciators, 409, 515
Thermocouple assemblies, 484
Timer, interval, 451
Tool holders, 512
Transducer, flow, 465
Transducer, pressure, 474
Transfer machine, 402
Transformer, chopper, 445
Transmission, power, 479
Transmitter, pressure, 460

Valves, 450
  plug-in, 426
  release, 430
  servo, 453
  solenoid, 457, 472, 525
  two-way, 444
Vane pumps, 497
Variable speed drive, 463
Vibrator, pneumatic, 461
Voltage controls, 442

Washer, 407
Weighing
  controls, 491
  indicators, 487
  machine, 419
Welding machines, 492
  pigtail, 408
Wire cutter & strippers, 411, 522

So that you won't have to clip this issue, we will gladly send you a personal copy of any article. Just fill in the page number and title of the article you desire.

MBERS

issue)

nt, 521
g press, 406
ng, 432
nponents, 426,
31, 444, 450,
71, 472, 476,

brator, 461
ystem, 462
monitor, 448
nlation, 479
itter, 475

g, 508
ding, 406
rol, 454

38, 490
474
460
415
chine, 425
hine, 401
system, 505
gas, 458

487
434, 501
el for, 484

ition system,

29
469
, 435
t-ammeter,

433
r, 452
, 449

e tools, 512
power, 523
68
453
, 475
es, 457, 472,

orized, 514
443
rs, 432
, mechanized,

, 522

d, 449
36, 490
induction mo-

ed profiler,

er, 416
control, 483
recorder, 435

rs, 409, 515
assemblies,

al, 451
512
low, 465
ressure, 474
hine, 402
chopper, 445
power, 479
pressure, 480

157, 472, 525
44
, 497
ed drive, 463
umatic, 461
rols, 442

91
487
19
hines, 492
3
& strippers,

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427	467	507	547	587	627	667	707	747	787	827
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430	470	510	550	590	630	670	710	750	790	830
431	471	511	551	591	631	671	711	751	791	831
432	472	512	552	592	632	672	712	752	792	832
433	473	513	553	593	633	673	713	753	793	833
434	474	514	554	594	634	674	714	754	794	834
435	475	515	555	595	635	675	715	755	795	835
436	476	516	556	596	636	676	716	756	796	836
437	477	517	557	597	637	677	717	757	797	837
438	478	518	558	598	638	678	718	758	798	838
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418	458	498	538	578	618	658	698	738	778	818
419	459	499	539	579	619	659	699	739	779	819
420	460	500	540	580	620	660	700	740	780	820
421	461	501	541	581	621	661	701	741	781	821
422	462	502	542	582	622	662	702	742	782	822
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Packaged Conveyo

Harry J. Ferguson Co. Jenkintown, Pa.—42 *pa* are given on line of conveyor units for horiz conveying. Types of co are roller conveyors, adj er units, gravity roller wheel conveyors in eith portable styles. Design plications are noted an construction of the cro discussed are accessories and end-drive units, en end idler pulleys, motors

Circle

Continuous Chlorin

Milton Roy Co., 1300 *Philadelphia* 18, *Pa.*—2 Operation of controlled Model LMD-31-74, as it stage continuous chlorin is described in Data Sh explained how the chem chlorine drying system by metering acid feed continuously. A flow system is also given.

Circle

Screw Machine Too

Ringo Co., P. O. Box Ohio—11 *page bulletin*- on adapter bushings, tap able drill holders, an holders. Specifications, plications are noted.

Circle

Industrial Hose

B. F. Goodrich Industr Akron, Ohio—2 *page* industry hose, which can neries and breweries as or to carry food, is the letin 3540. Specificatio of the different styles is not affected by temp and is especially suitable erages of high acid conte

Circle

Motorized Spindles

Cincinnati Electrical T Hope Ave., Cincinnati bulletin—Data are listed on 3 stlyes of motorize ½ to 10 hp. Tables mensions for feeds and scribed are accessories noses, wheel holders, wh mounting brackets.

Circle

Annunciator

Panellit Inc., 7401 *N Skokie, Ill.*—4 *page pa*

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ged Conveyor Units

J. Ferguson Co., 149 West Ave., wn, Pa.—42 page catalog—Data en on line of packaged power r units for horizontal or inclined ng. Types of conveyors described er conveyors, adjustable belt feed-s, gravity roller conveyors, and conveyors in either stationary or styles. Design features and ap-ns are noted and sketches show tion of the cross sections. Also d are accessories such as center d-drive units, end take-up units, er pulleys, motors, and belting.

Circle 510 on Page 155

uous Chlorine Drying

n Roy Co., 1300 E. Mermaid Lane, phia 18, Pa.—2 page pamphlet—on of controlled volume pump, LMD-31-74, as it is used in a two-ontinuous chlorine drying system, ibed in Data Sheet A-58-1. It is d how the chemical balances in drying system are maintained tering acid feed accurately and ously. A flow diagram of the is also given.

Circle 511 on Page 155

Machine Tools

Co., P. O. Box 863, Dayton 1, 1 page bulletin—Data are given ter bushings, tap bushings, adjust-rill holders, and floating tool Specifications, features, and ap-ns are noted.

Circle 512 on Page 155

rial Hose

Goodrich Industrial Products Co., Ohio—2 page pamphlet—Food hose, which can be used in can-nd breweries as a washdown hose arry food, is the subject of Bul-540. Specifications and features different styles are given. Hose affected by temperature of liquid especially suitable for carrying bev-f high acid content.

Circle 513 on Page 155

ized Spindles

nnati Electrical Tool Co., 371 Mt. Ave., Cincinnati 4, Ohio—8 page —Data are listed in Catalog S-58 tlyes of motorized spindles from 10 hp. Tables list various di-ns for feeds and slides. Also de-are accessories such as spindle wheel holders, wheel guards, and g brackets.

Circle 514 on Page 155

nciator

lit Inc., 7401 N. Hamlin Ave., Ill.—4 page pamphlet—Annunciator, described in Bulletin 103, is capable of monitoring complex automatic equipment used in continuous process industries. It is explained how the annunciator can be used with a multi-point recorder/scanner to monitor up to 96 points. Charts list mounting dimensions and operational sequence.

Circle 515 on Page 155

Drilling Circuit Boards

Zagar Inc., 2400 Lakeland Blvd., Cleveland 23, Ohio—6 page pamphlet—Printed circuit drilling is the subject of Bulletin 858. Three styles of drill presses which can be used in manufacture of printed circuit boards are described and illustrated. A schematic drawing shows the gearless drive arrangement which permits drilling of desired hole pattern. Instructions are also given for machining and assembly of quick-change inserts for the gearless drive head.

Circle 516 on Page 155

Ultrafine Grinding

Sturtevant Mill Co., 103 Clayton St., Dorchester, Boston 22, Mass.—4 page pamphlet—A fluid energy mill, for simultaneous grinding and classification to ultrafine particle size (below 44 microns), is discussed in Bulletin 091. Schematic drawings show the grinding chambers and flow diagrams show the air and steam requirements.

Circle 517 on Page 155

Drum-Type Controllers

Seely Instrument Co. Inc., subsidiary, Aeronautical Mfg. Corp., P. O. Box 387, Niagara Falls, N. Y.—8 page bulletin—Data are given on line of drum-type controllers which relate time and sequence of cyclical operations through electrical or pneumatic actuation. Specifications, safety features, and notes on installation are contained in booklet. Also included are basic wiring diagrams and a chart for gear selection.

Circle 518 on Page 155

Mechanized Storage Units

Harvestore Div., A. O. Smith Corp., Kankakee, Ill.—6 page pamphlet—Bulk material mechanized storage units suitable for use in manufacturing and processing plant are described in Bulletin PSU-220. A schematic diagram shows how the storage units can be incorporated in a handling system. Charts list storage data on three models. Also included are illustrative examples of various applications.

Circle 519 on Page 155

Metering & Control Systems

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—4 page pamphlet—Function, design, and operation of metering and control systems for different applications are described in Bulletin 500. The units which compose the systems are listed. Also included is a discussion of pneumatic and electric telemetering, and pneumatic control.

Circle 520 on Page 155

Basic Plant Equipment

Alden Systems Co., Alden Research Center, Westboro, Mass.— 81 page handbook—Handbook is divided into sixteen sections and describes "building-block" components which can be arranged for automatic production facilities. Some of the equipment in the various sections include conveyors, special machines for compact areas, and computer and electronic instruments for data processing. Also included are specifications, flow charts, and schematic drawings.

Circle 521 on Page 155

Wire Cutter & Stripper

Jennings Machine Corp., 3452 Ludlow St., Philadelphia 4, Pa.—4 page pamphlet—Automatic, high-speed wire cutter and stripper equipment is described which is capable of cutting up to 9000 pieces per hour of from 1 to 40-inch lengths. Illustrations show the operation of the cutter, feeder tube. Tables compare production rates and wire lengths for the different models. Tolerances, types of insulated wire handled and operating features are also covered.

Circle 522 on Page 155

Power Screwdriver

Detroit Power Screwdriver Co., 2801 W. Fort St., Detroit 16, Mich.— 6 page pamphlet—Power screwdriver, designated Model U, is the subject of booklet. Advantages of the positive control clutch, hopper driving mechanism, and feed track and escapement mechanism are listed. Schematic drawings show the dimensional details of the unit.

Circle 523 on Page 155

Turbine Flowmeter

Fischer & Porter Co., 786 Jacksonville Rd., Hatboro, Pa.—4 page pamphlet—Turbine flowmeter, a propellor type meter that translates liquid velocity into a millivolt signal proportional to flow rate, is described in Bulletin 10C1505. Performance characteristics and construction materials are listed. Charts show capacity, frequency output, and pressure drop characteristics.

Circle 524 on Page 155

Solenoid Valve Guide

Automatic Switch Co., Hanover Rd., Florham Park, N. J.—8 page bulletin—Bulletin 505 is a selection guide on line of two, three, and four-way solenoid valves. Data on two-way strainers are included. Flow diagrams are shown and prices, valve ratings, and pipe sizes listed.

Circle 525 on Page 155

Linear Actuating Equipment

Airborne Instruments Laboratory Inc., 1345 New York Ave., Huntington Station, N. Y.—11 page bulletin—Equipment which can be used as an actuator for automatic grinder systems is described. Principle of operation is explained and the action of the equipment cycle is shown by drawings. The different styles are noted and their specific application given.

Circle 526 on Page 155

THE RELIANCE SUPER 'T'

A New Kind of D-c. Motor With DYNAMIC RESPONSE

Here is a motor built to make maximum use of d-c. flexibility. The Super "T" puts Dynamic Response into starts, stops, and speed changes. Dynamic Response gives you a 50% increase in torque and a 50% decrease in reaction time.

This top performance is due to advanced, balanced design. Lighter small diameter armatures cut mechanical inertia 50%. Superior Class B insulation, gives extended life even at temperatures as great as 130°C.

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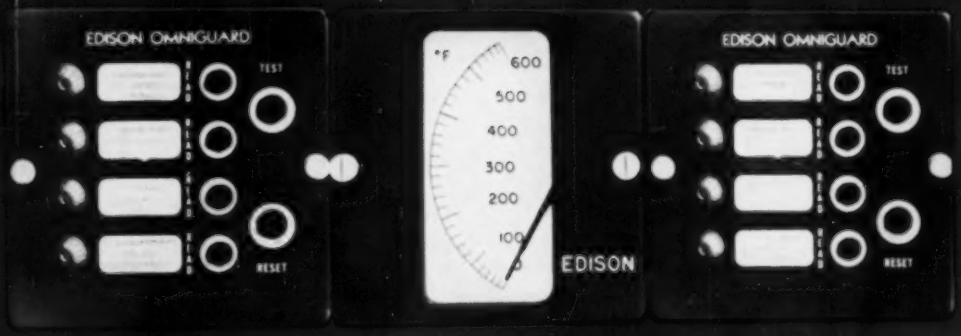
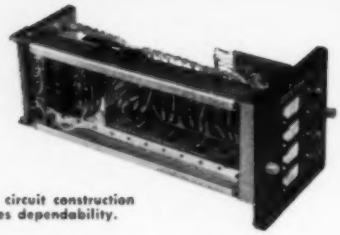
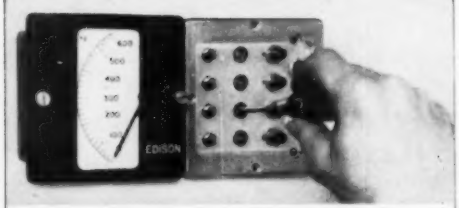
Circle 652 on Page 155





Printed circuit construction increases dependability.

Highest quality components, with no moving parts, assure maintenance-free operation.



Easy access to all components permits quick temperature settings and monitoring system changes – at any time.

Model 310 Edison Omniguard with Model 311 Indicator – a single indicator can read any number of temperature points.

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The Omniguard system is reliable... flexible... economical. You order only the plug-in units needed, add new units as your monitoring needs expand.

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1. **VERSATILE:** One instrument can be used for both normally open and normally closed annunciator... for alarm or for shutdown of equipment.

2. **FLEXIBLE:** Quick, inexpensive system changes and additions . . . easy tie-in with any type annunciators or cut-off switches.

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4. **SIMPLE:** Single indicator reads any number of temperatures, needs no periodic adjustment. With a minute's briefing, *anyone* can operate the simple Omniguard monitoring system.

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Circle 653 on Page 155